

Daily report

12-05-2020

Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries

Foreword

The present report aims to provide a comprehensive picture of the **pandemic situation of COVID-19** in the EU countries, and to be able to foresee the situation in the next coming days.

We employ an **empirical model**, verified with the evolution of the number of confirmed cases in previous countries where the epidemic is close to conclude, including all provinces of China. The model does not pretend to interpret the causes of the evolution of the cases but to permit the **evaluation of the quality of control measures made in each state** and a **short-term prediction of trends**. Note, however, that the effects of the measures' control that start on a given day are not observed until approximately 7-10 days later.

The model and predictions are based on two parameters that are daily fitted to available data:

- ✓ α : the velocity at which spreading specific rate slows down; the higher the value, the better the control.
- ✓ K : the final number of expected cumulated cases, which cannot be evaluated at the initial stages because growth is still exponential.

We show an individual report with 8 graphs and a table with the **short-term predictions** for different countries and regions. We are adjusting the model to **countries and regions** with at least 4 days with more than 100 confirmed cases and a current load over 200 cases. The **predicted period** of a country depends on the number of datapoints over this 100 cases threshold, and is of 5 days for those that have reported more than 100 cumulated cases for 10 consecutive days or more. For short-term predictions, we assign higher weight to last 3 points in the fittings, so that changes are rapidly captured by the model. The whole methodology employed in the inform is explained in the last pages of this document.

In addition to the individual reports, the reader will find an initial dashboard with a brief analysis of the situation in EU-EFTA-UK countries, some summary figures and tables as well as **long-term predictions** for some of them, when possible. These long-term predictions are evaluated without different weights to datapoints. We also discuss a specific issue every day.

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PJC and MC received funding from "la Caixa" Foundation (ID 100010434), under agreement LCF/PR/GN17/50300003; CP, DL, SA, MC, received funding from Ministerio de Ciencia, Innovación y Universidades and FEDER, with the project PGC2018-095456-B-I00;

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(0) Executive summary – Dashboard

Global EU+EFTA+UK trends and needs

The situation in the USA may seem catastrophic, but before stating assessments it is good to compare it with other actors. USA is a huge state with about 407 million inhabitants. Therefore, it is **comparable in size to EU+EFTA+UK**, with 484 million inhabitants. If we fit the Gompertz model to USA cumulative cases and to EU+EFTA+UK as a whole, we find that they are really comparable. In fact, the situation in Europe is probably worse in some aspects. **In the USA, the model currently predicts a final picture of**

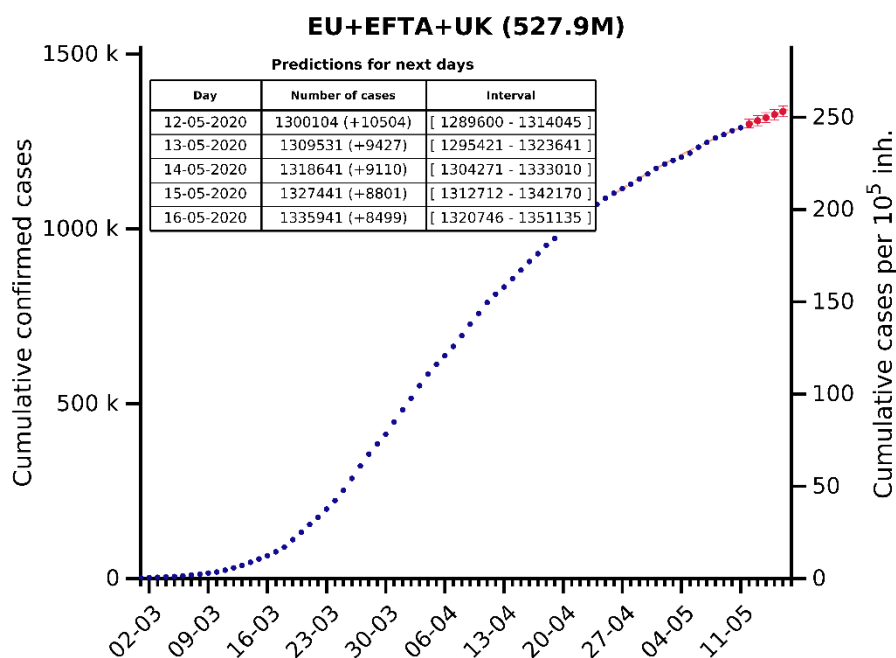
about 1.7 million infected and about 130,000 deaths. In Europe, predictions point to 1.4 million cases and about 180,000 deaths. The number of cases, even if we consider its ratio per population, is lower in Europe, but the death toll is not. If current trends are maintained, the USA they can reach 32 deaths per 100,000 inhabitants and in Europe we would reach about 38 deaths per 100,000 inhabitants. These are the forecasts if we consider the Gompertz fitting, with an R^2 of over 0.999 (except for US mortality, with an R^2 of 0.996). The fitting excellent, but the deconfinement phase can slow down current trends and then the values could increase significantly.

In the last section we analyse the timeline of the epidemic in Europe, looking at the particular dynamics in the countries.

Trends for specific countries

United Kingdom and **Sweden** present similar EPG (94 and 92 respectively), although there is one order of magnitude difference between absolute number of new cases (4,000 and 400-700, respectively). Cumulative incidence is higher in **UK** (329 per 10^5 inh.) than in **Sweden** (264 per 10^5 inh.), but their 14-day attack rates are closer (99 and 79 per 10^5 inhabitants, respectively). There are many countries with a p_7 close to 1, but this is not necessarily worrying if it is not combined with a moderate or high number of active cases. Therefore, most EPGs are at the low risk level. High p_7 of **Portugal** is probably related with some problems on reporting data. **France** still presents a p_7 affected by the one-day peak of the last week.

The maps are today included in the Analysis section.



Situation and trends per country

Table of current situation in EU countries. Colour scale is relative except when indicated, this means that it is applied independently to each column, and distinguishes best (green) from worst (red) situations according to each of the variables. Last column (EPG_{EST}) indicates EPG assessed with **estimated real 14-day attack rate** (see report from 22/04 for details). EPG_{REP} is calculated with **data reported by countries**. EPG_{REP} and EPG_{EST} **cannot be compared between them** because scales are different, but can be independently used for estimating risk of countries according to reported or estimated real situation, respectively.

Country	Reported data						Indexes		
	Cumulative cases	Attack rate /10 ⁵ inh.	Cumulative deaths	Mortality /10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate /10 ⁵ inh.	$\rho_7^{(1)}$	$EPG_{REP}^{(2)}$	$EPG_{EST}^{(3)}$
Spain	227.660	491,2	26.744	57,7	16.732	36,1	1,14	41	493
United Kingdom	223.060	335,7	32.065	48,3	65.911	99,2	0,95	94	1.439
Italy	219.814	369,9	30.739	51,7	20.400	34,3	0,73	25	351
Germany	170.508	208,2	7.533	9,2	14.171	17,3	0,94	16	75
France	139.519	215,6	26.643	41,2	13.749	21,2	1,38	29	582
Belgium	53.449	470,6	8.707	76,7	6.762	59,5	1,09	65	1.095
Netherlands	42.788	251,9	5.456	32,1	4.543	26,7	0,84	22	296
Switzerland	30.261	353,1	1.542	18,0	1.180	13,8	0,61	8	44
Portugal	27.679	266,9	1.144	11,0	3.535	34,1	1,84	63	283
Sweden	26.670	271,1	3.256	33,1	7.744	78,7	1,16	92	1.254
Ireland	23.135	489,5	1.467	31,0	3.487	73,8	0,73	54	358
Poland	16.326	42,7	811	2,1	4.424	11,6	1,09	13	75
Austria	15.874	182,2	620	7,1	618	7,1	1,02	7	28
Romania	15.588	78,8	972	4,9	4.249	21,5	1,04	22	162
Denmark	10.513	184,1	533	9,3	1.815	31,8	0,92	29	153
Czech Republic	8.176	77,1	282	2,7	727	6,9	1,02	7	25
Norway	8.106	151,0	224	4,2	573	10,7	1,03	11	31
Finland	5.984	108,7	271	4,9	1.289	23,4	1,06	25	131
Luxembourg	3.888	675,0	101	17,5	159	27,6	0,72	20	48
Hungary	3.313	34,0	425	4,4	664	6,8	0,70	5	66
Greece	2.726	24,4	151	1,4	192	1,7	1,04	2	11
Croatia	2.196	52,1	91	2,2	157	3,7	1,76	7	NA
Bulgaria	1.990	27,9	93	1,3	627	8,8	1,34	12	NA
Iceland	1.801	494,4	10	2,7	9	2,5	0,74	2	NA
Estonia	1.741	132,7	61	4,6	94	7,2	1,07	8	NA
Lithuania	1.485	51,1	50	1,7	36	1,2	1,04	1	NA
Slovenia	1.460	70,3	102	4,9	53	2,6	0,75	2	14
Slovakia	1.457	26,8	26	0,5	76	1,4	1,49	2	NA
Latvia	946	48,0	18	0,9	128	6,5	0,94	6	NA
Cyprus	901	77,0	22	1,9	79	6,8	0,63	4	NA
Malta	503	117,2	5	1,2	53	12,4	NA	NA	NA
Liechtenstein	83	215,3	1	2,6	0	0,0	NA	NA	NA

Scale									
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	200	2000
Best	Best	Best	Best	Best	Best	Best	0,0	0	0

⁽¹⁾ ρ_3 is the average of 7 consecutive ρ , but can still fluctuate. ⁽²⁾ EPG stands for Effective Growth Potential. EPG_{REP} is obtained by multiplying attack rate of last 14 days per 10⁵ inhabitants (i.e. density of cases) by ρ_7 (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG_{EST} is obtained by multiplying estimated real attack rate of last 14 days per 10⁵ inhabitants by ρ_7 .

Highlights for countries with highest number of reported cases

- ✓ Spain is revising the historical series of Catalunya, one of the regions with highest incidence, whose data are behind the observed one-day peak.
- ✓ UK could start a slow decreasing trend the next days, but this still has to be confirmed during this week.
- ✓ Germany shows an increase in ρ_7 that can be related with the deconfinement process.

Analysis: Epidemic timeline at European level.

The European onset of Covid19 local contagions was in Italy, last week of February. If we take the threshold of 100 cumulative cases to determine the onset, this value was reached on February 24. According to data reported by countries, France and Germany overcame the 100 cases on March 1, and Spain 2 days later. Belgium, Netherlands, Sweden, Norway, Switzerland and United Kingdom reached this level between 6 and 7 March. Globally, temporal variation in the onset is relatively low (1 month), but subsequent evolution drastically varied from one country to another. In the next table, we show:

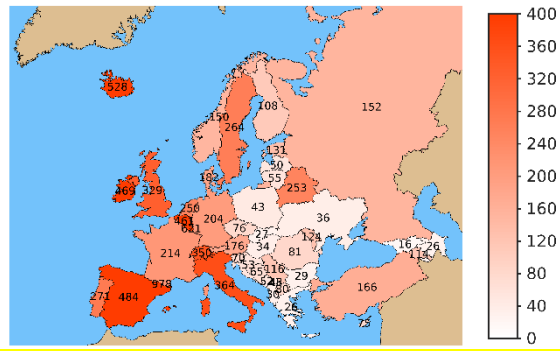
- The days from onset, taking onset as the moment at which 100 cases were reached.
- The time from a cumulative incidence of 1 case per 10^5 inhabitants to 10 cases per 10^5 inh.
- The time from a cumulative incidence of 10 cases per 10^5 inhabitants to 100 cases per 10^5 inh.

Colour scale indicate if **first and second growth stages were rapid (red) or slow (green)**. As seen, there is a wide variety of velocities among countries. Iceland, Denmark, Estonia, Slovenia and Luxembourg took 4-6 days for the first time interval. Nevertheless, second stage was faster in Luxembourg (7 days), Spain (12), Switzerland (12), Austria (14), Belgium (14), Iceland (15) and Finland (15).

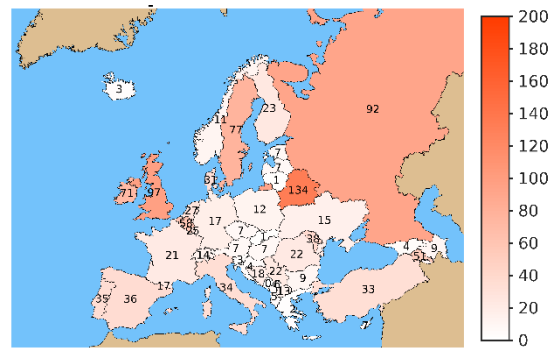
Countries	Days since the first 100 cases	Time interval between 1 and 10 cases / 10^5 inh. (days)	Time interval between 10 and 100 cases / 10^5 inh. (days)
Italy	79	11	16
Germany	73	12	17
France	72	10	20
Spain	71	8	12
United Kingdom	68	11	19
Belgium	67	11	14
Netherlands	67	11	20
Sweden	67	10	28
Norway	67	9	24
Switzerland	67	9	12
Austria	65	10	14
Denmark	64	4	30
Czech Republic	61	11	NA
Finland	61	12	46
Greece	61	18	NA
Iceland	61	5	15
Portugal	60	9	15
Slovenia	60	6	NA
Estonia	59	5	30
Ireland	59	8	18
Poland	59	17	NA
Romania	59	15	NA
Luxembourg	56	6	7
Slovakia	55	24	NA
Bulgaria	54	30	NA
Croatia	54	12	NA
Hungary	53	20	NA
Latvia	53	12	NA
Lithuania	52	9	NA
Cyprus	50	12	NA
Malta	50	8	34

The current situation is shown in the following maps. We show the current distribution of cumulative incidence, 14-day attack rate (A_{14}), 7-day average spreading rate (p_7) and EPG index.

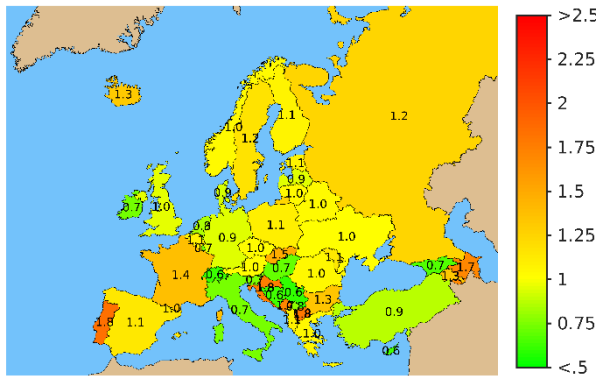
**Cumulative incidence per region
(data from 12th May)**



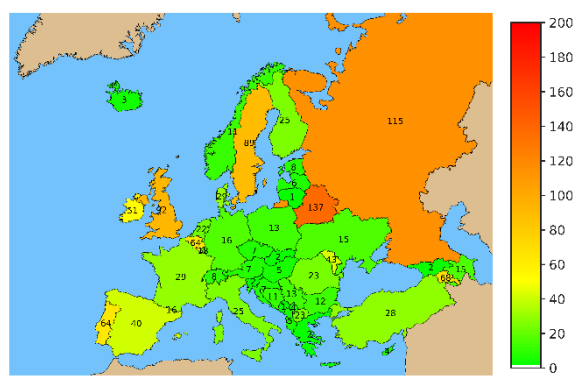
**A₁₄ per region
(data from 10th May)**



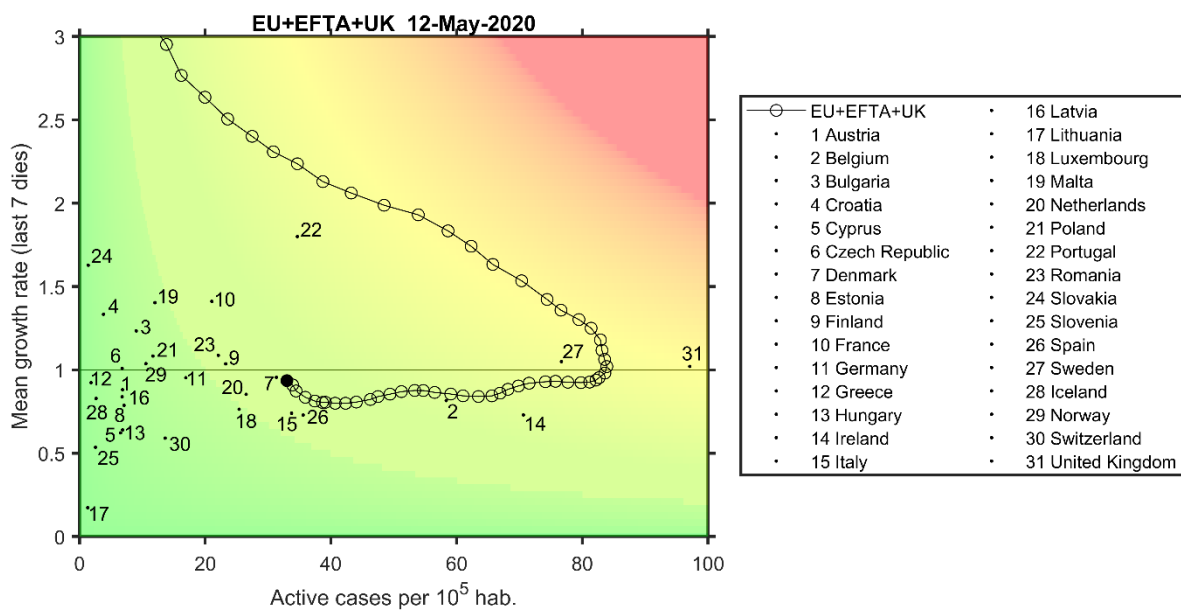
**ρ_7
(data from 12th May)**



**EPG per country
(data from 12th May)**



A visual way to see the current situation is to locate countries in the risk diagram. The next figure shows the **EU+EFTA+UK risk diagram together with the current situation of individual countries**. Europe as a whole has reached intermediate-risk values since it comprises countries that have been in a worrying situation but also countries where Covid19 has not penetrated significantly. Currently, the UK, Sweden, Ireland, Portugal, and Belgium are at intermediate risk, still (yellow zones). The remaining countries are close to or already in the green zone.

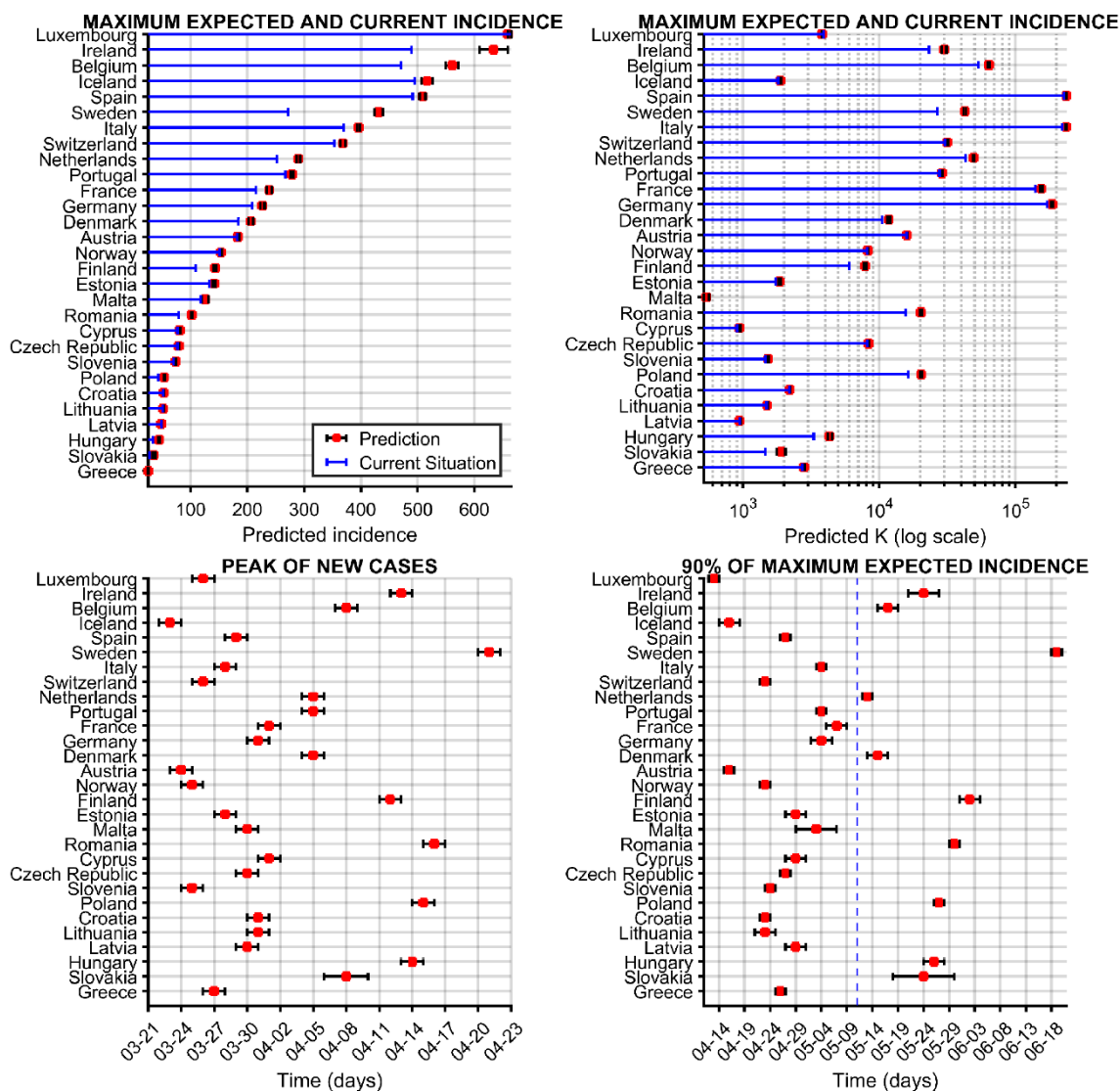


The particular evolution of each country can be visualized through the risk dashboard that we introduced yesterday. In the following figure, we show a sample of a few countries. The whole risk dashboard can be found as an appendix file of this report.

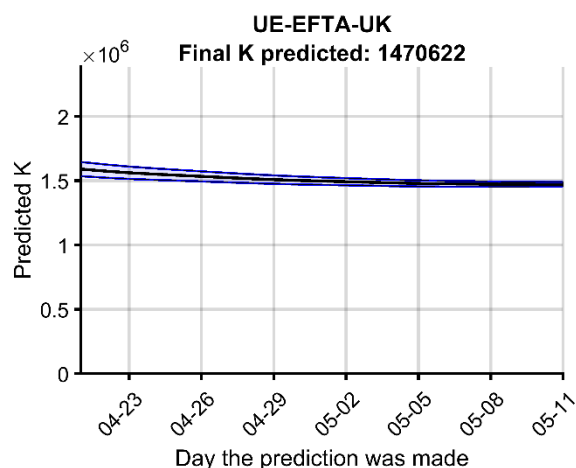
	EU+EFTA+UK			Austria			Belgium			Bulgaria			Croatia			Cyprus			Czech Republic			Denmark		
	p7	A14	EPG	p7	A14	EPG	p7	A14	EPG	p7	A14	EPG	p7	A14	EPG	p7	A14	EPG	p7	A14	EPG	p7	A14	EPG
09/03/2020	3.34	2	8	3.53	1	4	4.00	2	7	0.86	0	0	0.86	0	0	0.00	0	0	3.94	0	1	3.66	1	2
10/03/2020	3.30	3	10	3.50	1	5	4.00	2	8	1.43	0	0	0.71	0	0	0.29	0	0	3.94	0	1	3.80	2	7
11/03/2020	3.22	3	11	3.61	2	7	3.76	2	9	1.71	0	0	0.60	0	0	0.57	0	0	3.94	1	2	3.80	5	17
12/03/2020	3.19	4	14	3.59	3	10	3.36	3	9	2.14	0	0	0.81	0	0	1.14	0	1	3.94	1	3	3.94	9	35
13/03/2020	3.17	6	18	3.65	4	14	2.95	3	10	2.71	0	1	1.29	1	1	1.71	0	1	3.94	1	4	3.94	12	46
14/03/2020	3.13	7	22	3.65	6	20	2.65	5	13	3.29	0	1	1.79	1	1	2.29	1	3	3.94	1	6	3.94	14	55
15/03/2020	3.05	8	26	3.65	7	26	2.49	6	15	3.57	1	2	2.21	1	2	2.86	2	5	4.00	2	8	3.87	14	55
16/03/2020	2.95	10	30	3.65	9	34	2.49	8	19	3.57	1	3	2.71	1	3	3.43	2	9	4.00	3	11	3.47	15	52
17/03/2020	2.77	12	33	3.62	11	40	2.49	9	23	3.57	1	3	3.21	1	4	3.71	3	12	3.88	3	12	2.94	16	47
18/03/2020	2.64	14	36	3.52	15	51	2.65	11	28	3.59	1	4	3.49	1	5	4.00	3	13	3.72	4	15	2.42	18	42
19/03/2020	2.50	16	41	3.46	18	62	2.78	13	35	3.37	1	4	3.47	2	6	3.76	5	18	3.51	5	17	1.91	19	36
20/03/2020	2.40	20	48	3.40	24	81	2.89	15	44	2.98	2	5	3.23	2	7	3.36	5	16	3.36	6	21	1.44	20	28
21/03/2020	2.31	24	54	3.21	29	92	2.91	19	54	2.65	2	5	3.01	3	8	2.95	6	16	3.16	8	26	1.03	21	22
22/03/2020	2.24	27	61	3.02	32	98	2.86	23	65	2.40	2	6	3.01	5	14	2.52	7	18	2.93	9	27	0.78	22	17
23/03/2020	2.13	31	66	2.75	39	108	2.70	28	75	2.12	3	6	3.01	5	16	2.23	8	18	2.67	11	28	0.83	23	19
24/03/2020	2.06	35	71	2.58	48	125	2.48	30	75	1.80	3	5	3.01	7	22	1.91	9	18	2.43	11	27	0.91	23	21
25/03/2020	1.99	39	77	2.43	57	138	2.28	35	79	1.69	3	5	3.18	9	29	1.65	10	17	2.18	12	27	1.04	23	24
26/03/2020	1.93	43	83	2.33	63	146	2.21	40	88	1.65	3	6	3.38	10	33	1.52	10	16	1.96	15	29	1.18	21	25
27/03/2020	1.83	48	89	2.18	74	161	2.20	50	111	1.60	3	6	3.27	11	37	1.51	12	18	1.80	18	33	1.36	21	28
28/03/2020	1.74	54	94	2.04	80	163	2.17	58	126	1.49	4	6	3.14	14	42	1.50	12	18	1.70	20	34	1.46	21	31
29/03/2020	1.63	59	96	1.85	85	156	2.22	73	162	1.34	4	6	2.75	15	42	1.49	13	19	1.78	23	41	1.56	24	37
30/03/2020	1.53	62	96	1.66	88	146	2.25	86	194	1.26	4	5	2.36	16	38	1.45	15	22	1.75	24	41	1.66	26	44
31/03/2020	1.42	66	94	1.44	96	138	2.33	93	217	1.17	4	5	1.95	18	35	1.47	16	23	1.75	25	43	1.77	28	50
01/04/2020	1.36	70	96	1.28	98	125	2.25	100	223	1.13	5	5	1.58	19	31	1.54	18	28	1.70	27	46	1.82	32	58
02/04/2020	1.30	74	97	1.14	101	115	2.18	108	234	1.10	5	5	1.30	21	28	1.75	22	38	1.67	29	48	1.84	34	63
03/04/2020	1.25	77	96	0.97	99	96	2.03	117	237	1.13	5	6	1.21	22	27	1.97	25	49	1.54	30	46	1.80	39	69
04/04/2020	1.18	79	94	0.84	99	83	1.88	125	236	1.15	5	6	1.13	23	26	2.10	27	57	1.44	31	44	1.78	43	77
05/04/2020	1.12	81	91	0.73	97	71	1.62	135	218	1.16	5	6	1.06	22	24	2.19	28	62	1.18	32	38	1.71	47	81
06/04/2020	1.06	83	88	0.68	93	63	1.34	141	188	1.11	5	6	0.99	23	23	2.10	29	61	1.07	32	34	1.64	51	84
07/04/2020	1.02	83	85	0.62	87	54	1.09	147	161	1.06	5	5	0.92	22	20	1.93	29	56	0.97	33	33	1.60	56	89
08/04/2020	0.98	84	82	0.59	82	48	1.04	155	161	1.01	5	5	0.86	22	19	1.61	31	49	0.95	34	32	1.55	60	93
09/04/2020	0.95	84	80	0.59	79	46	1.02	159	163	0.97	5	5	0.79	23	18	1.30	33	42	0.95	34	32	1.49	63	95
10/04/2020	0.94	84	78	0.62	69	43	1.04	162	168	0.94	5	5	0.82	22	18	1.05	35	36	0.95	33	31	1.39	65	90
11/04/2020	0.93	83	77	0.67	65	44	1.06	167	178	0.91	5	4	0.86	22	19	0.93	36	33	0.92	32	30	1.25	65	81
12/04/2020	0.92	82	76	0.75	61	46	1.09	163	177	0.88	5	4	0.94	21	20	0.89	36	32	0.88	30	27	1.08	66	71
13/04/2020	0.93	81	75	0.80	57	45	1.09	162	178	0.83	5	4	1.00	22	22	0.88	35	31	0.83	30	25	0.94	65	62
14/04/2020	0.93	80	74	0.81	49	40	1.06	161	171	0.82	5	4	1.05	21	22	0.91	36	32	0.78	29	22	0.83	65	53
15/04/2020	0.93	78	72	0.79	45	36	1.01	158	160	0.81	5	4	1.08	20	22	0.94	36	34	0.73	26	19	0.73	63	46
16/04/2020	0.92	76	70	0.75	41	31	1.00	169	170	0.89	5	4	1.07	19	20	0.97	33	32	0.68	25	17	0.66	62	41
17/04/2020	0.90	74	67	0.69	37	26	1.00	168	168	1.00	5	5	1.01	19	19	0.96	31	30	0.65	24	16	0.66	60	40
18/04/2020	0.88	72	63	0.61	34	21	1.01	167	168	1.26	5	7	0.92	18	16	0.88	28	25	0.65	22	14	0.70	57	40
19/04/2020	0.86	70	60	0.55	32	18	0.98	162	158	1.48	5	8	0.81	17	14	0.79	28	22	0.67	20	14	0.76	55	42
20/04/2020	0.84	68	58	0.52	30	16	0.97	162	157	1.70	6	9	0.70	17	12	0.70	27	19	0.77	21	16	0.83	52	43
21/04/2020	0.84	67	56	0.51	28	14	0.96	165	158	1.75	5	10	0.63	16	10	0.65	25	17	0.87	20	17	0.88	49	43
22/04/2020	0.84	66	55	0.51	24	12	0.98	162	158	1.77	6	10	0.58	15	9	0.58	24	14	0.97	19	18	0.92	45	42
23/04/2020	0.86	63	54	0.52	22	11	0.95	160	152	1.71	6	11	0.59	15	9	0.55	22	12	1.03	17	18	0.96	43	42
24/04/2020	0.86	61	53	0.55	19	11	0.93	154	143	1.65	7	11	0.64	14	9	0.50	19	10	1.05	15	16	0.97	42	41
25/04/2020	0.88	59	52	0.60	17	10	0.91	152	138	1.54	8	12	0.74	13	9	0.51	17	9	1.01	14	14	0.96	41	40
26/04/2020	0.88	57	50	0.68	15	10	0.90	149	135	1.55	8	13	0.79	12	9	0.49	16	8	0.94	14	13	0.97	42	41
27/04/2020	0.87	55	48	0.77	14	11	0.86	142	122	1.53	9	14	0.82	10	9	0.57	15	9	0.81	13	11	0.99	41	41
28/04/2020	0.85	53	46	0.83	13	11	0.82	139	114	1.60	10	16	0.80	9	8	0.61	13	8	0.71	13				

Long-term predictions

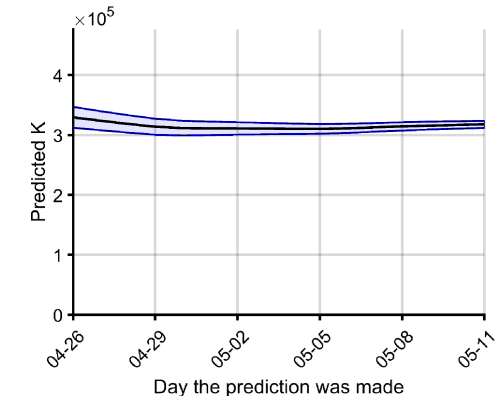
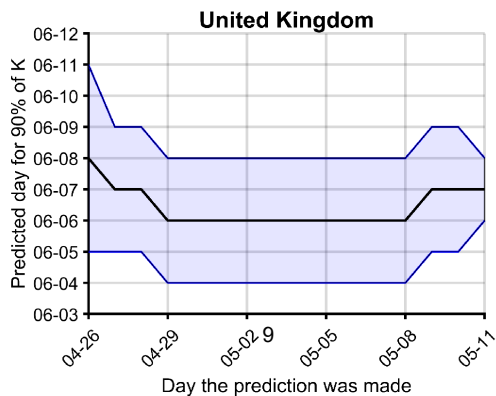
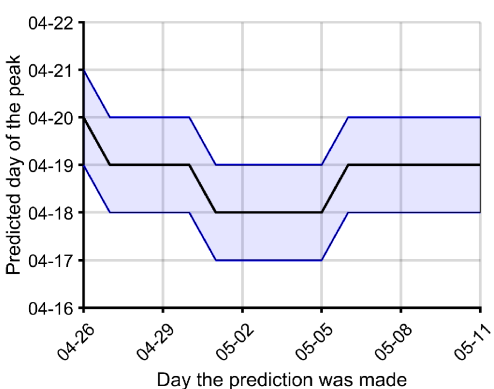
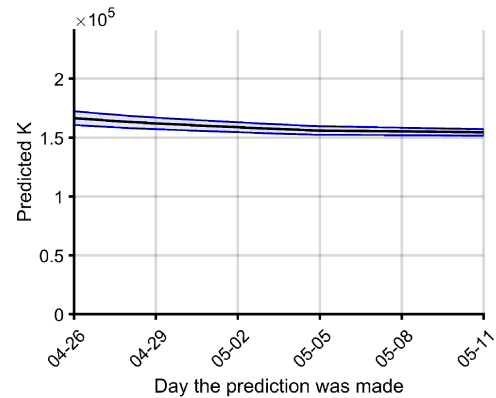
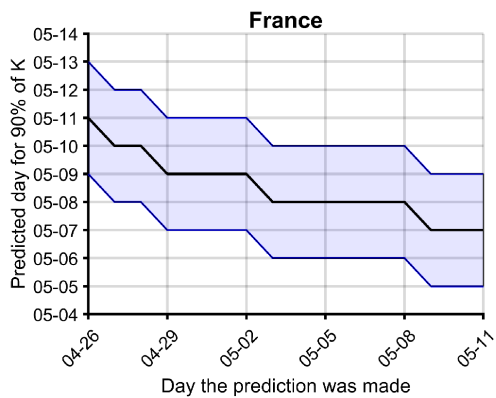
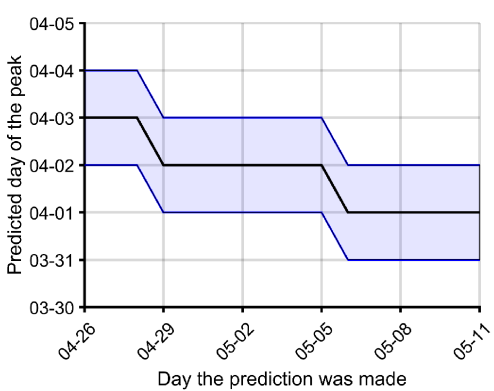
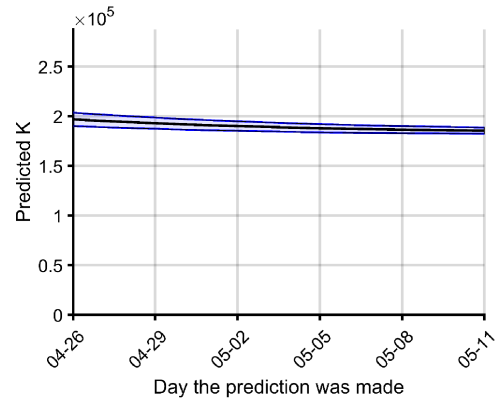
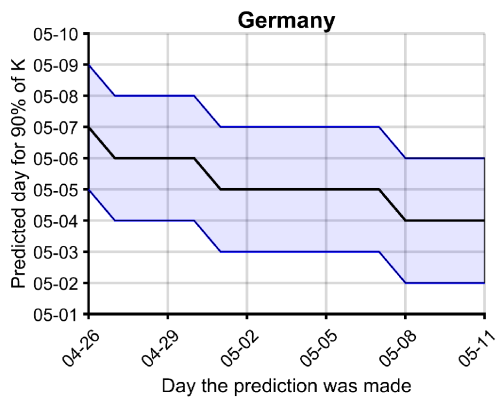
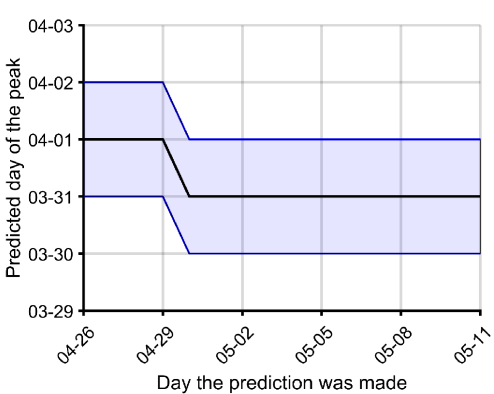
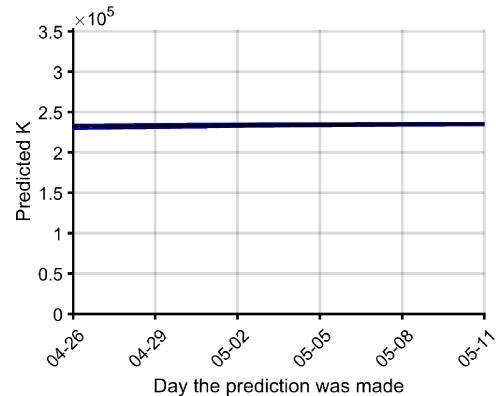
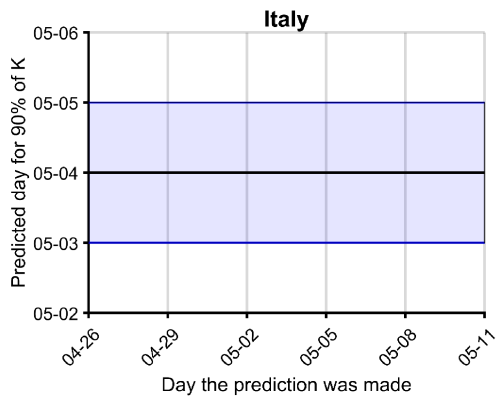
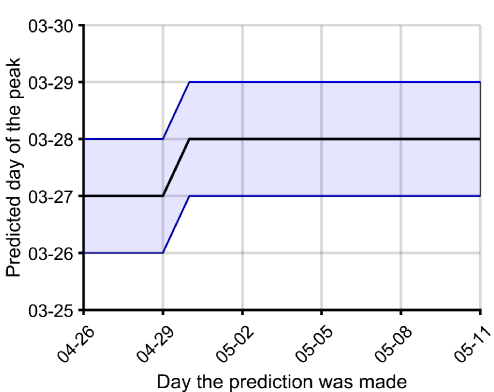
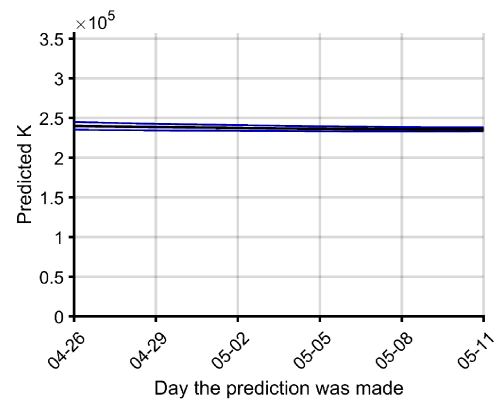
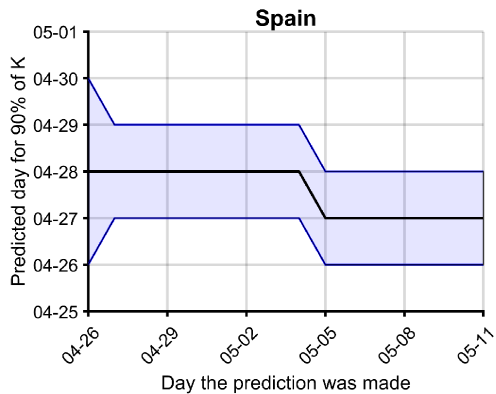
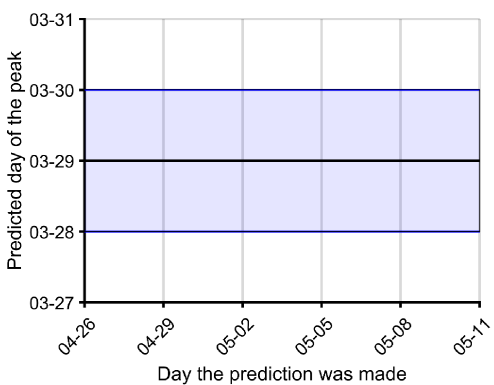
Long-term predictions, evaluated with the **whole historical series** and without weighting last 3 points. Up-left: Predictions of maximum incidences per country (total final expected attack rate per 10^5 inh.). Up-right: Predictions of maximum absolute number of cases per country (K, in log scale). Blue lines indicate current situation. Bottom-left: Time in which peak in new cases was achieved / will be achieved. Bottom-right: Time at which 90 % of K was achieved / will be achieved. Blue dotted line indicates current date.



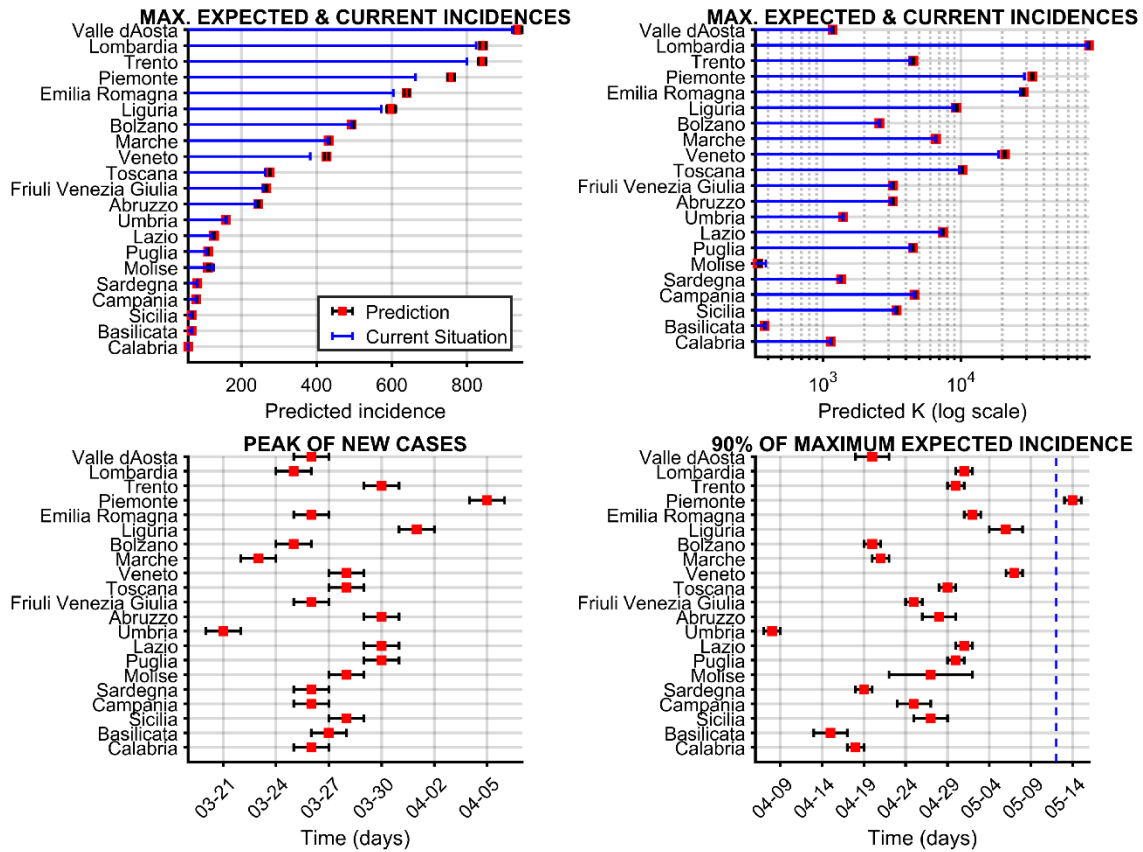
Final expected K for UE+EFTA+UK. Evolution of predicted K with time, where convergence to best estimate is seen. Last prediction is numerically shown in title.



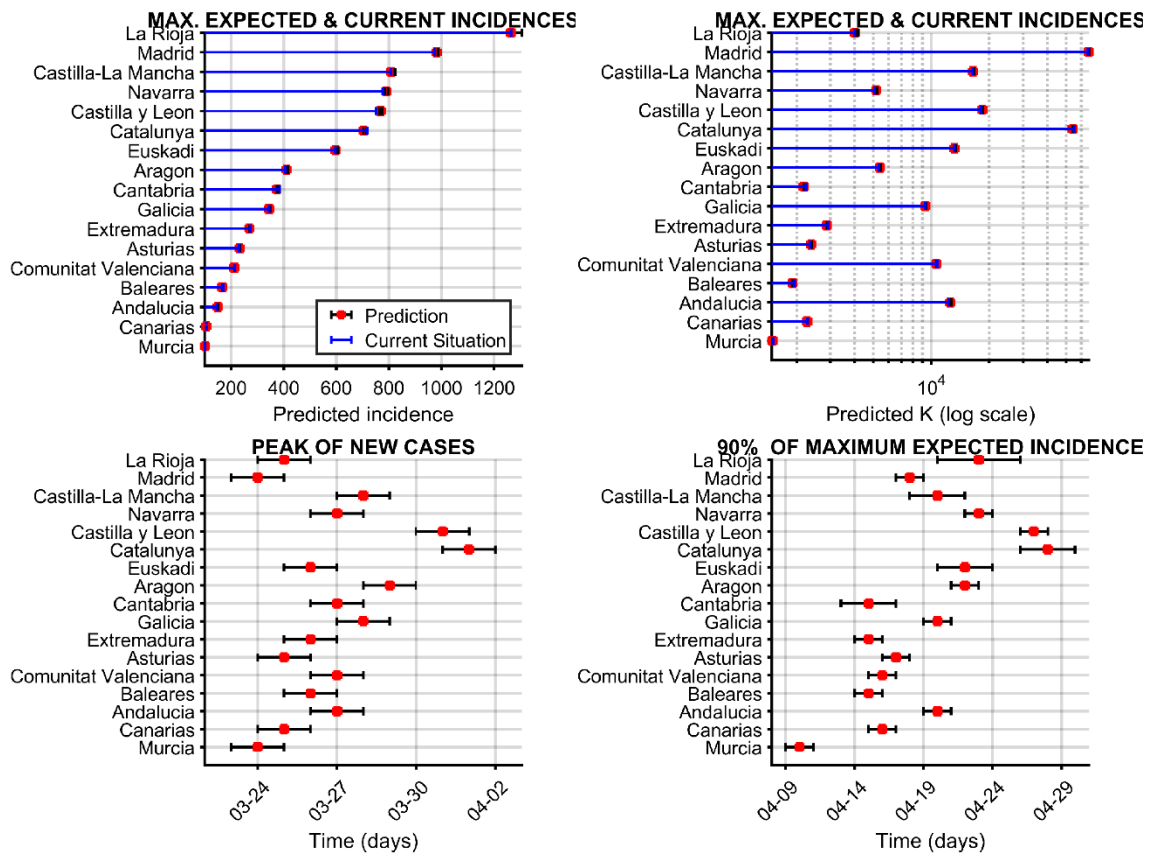
2020-05-11



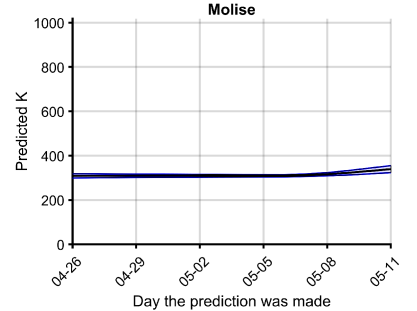
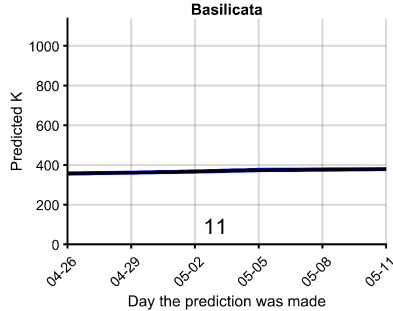
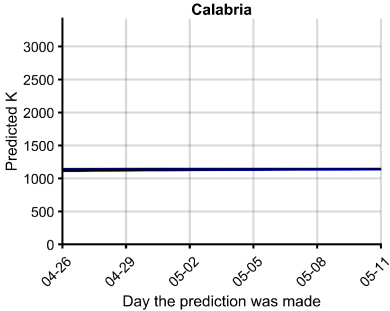
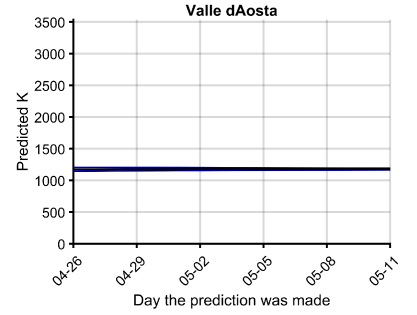
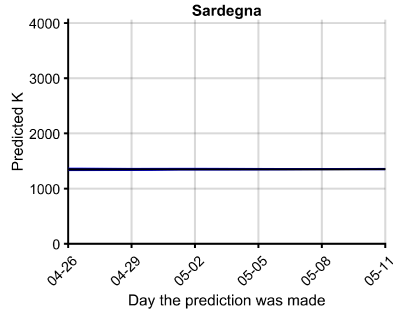
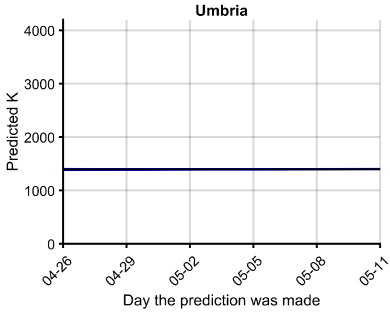
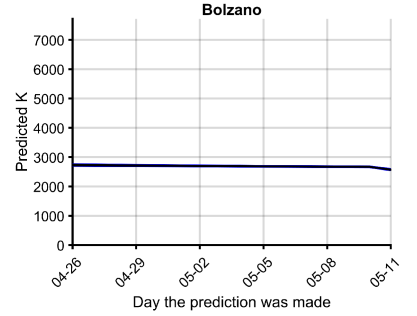
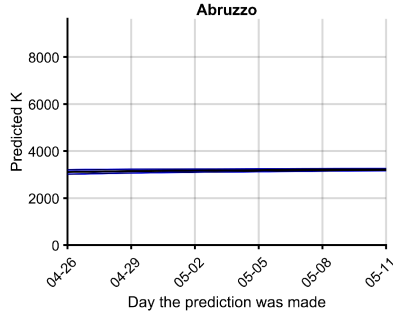
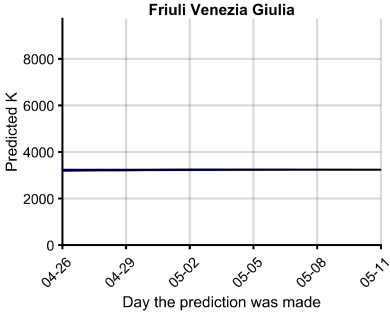
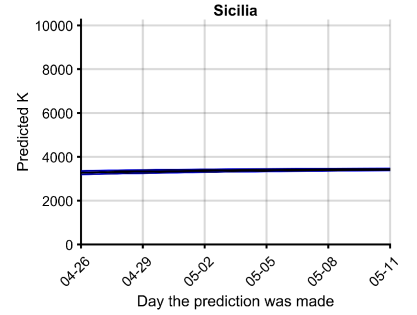
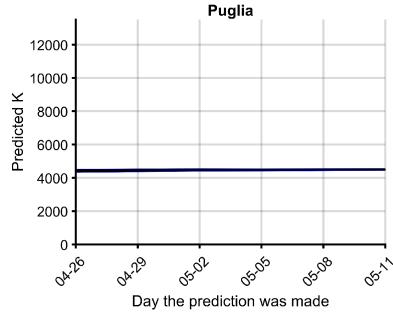
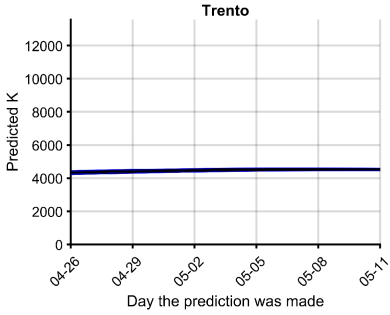
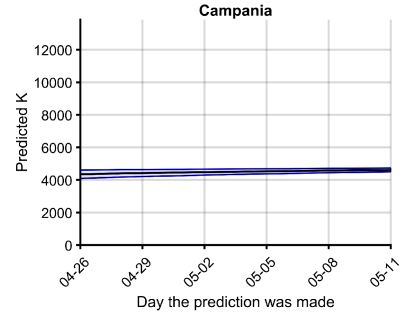
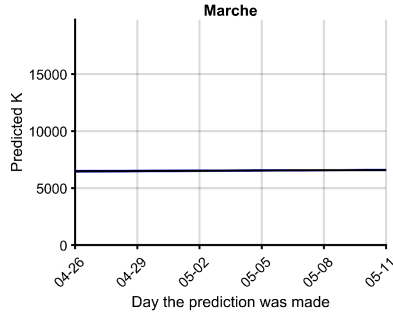
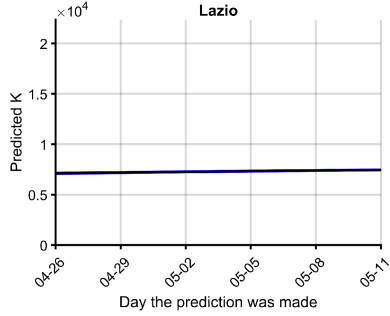
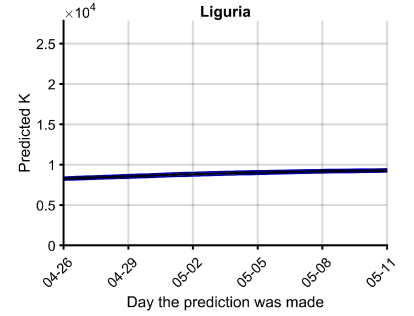
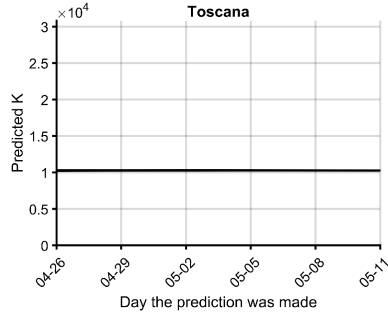
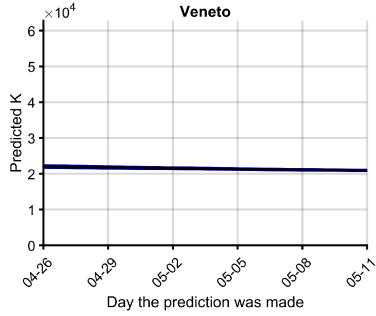
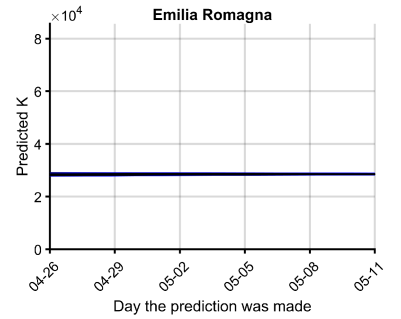
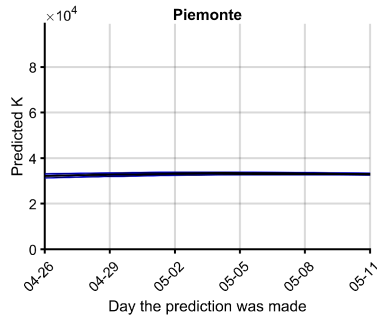
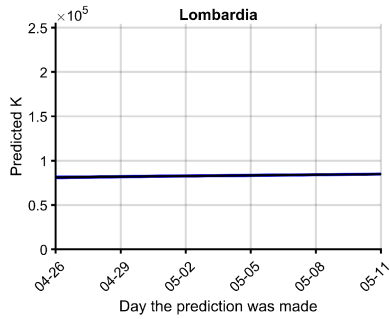
Italian regions



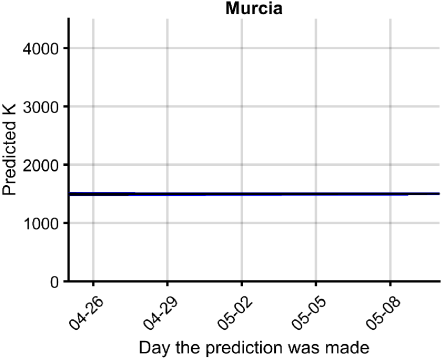
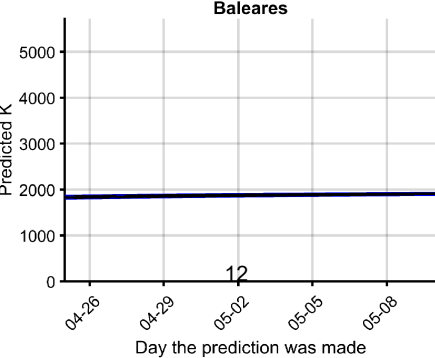
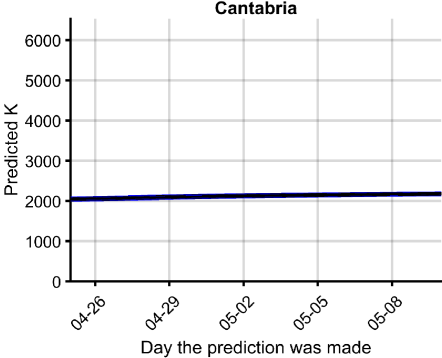
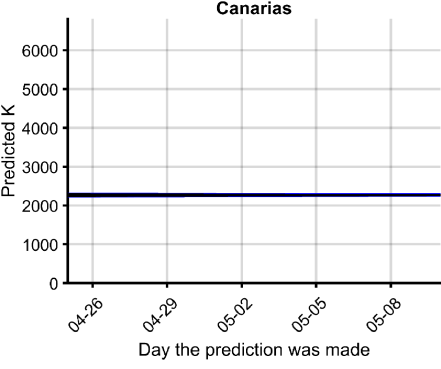
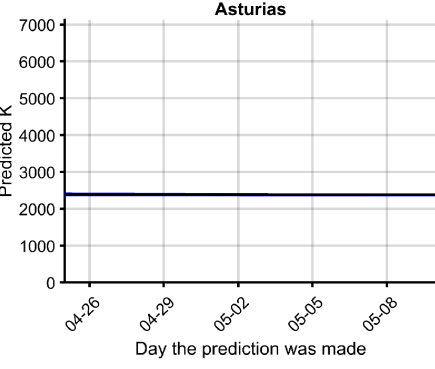
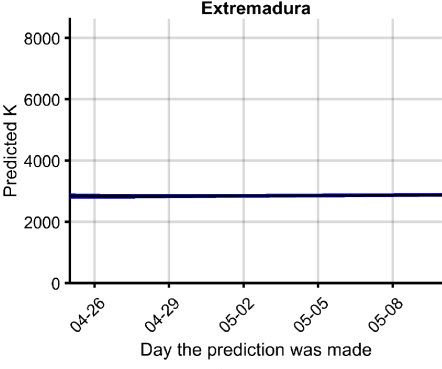
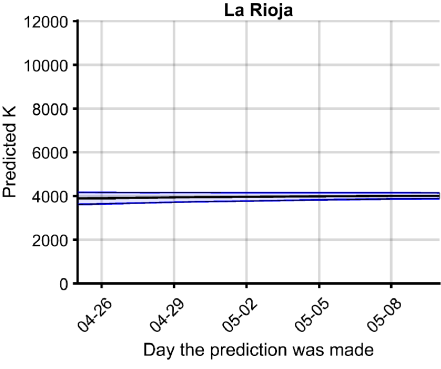
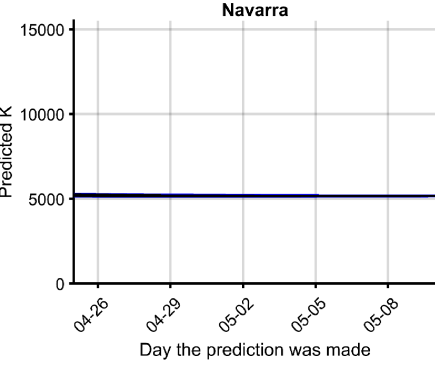
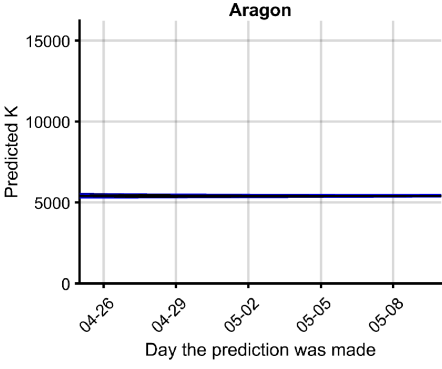
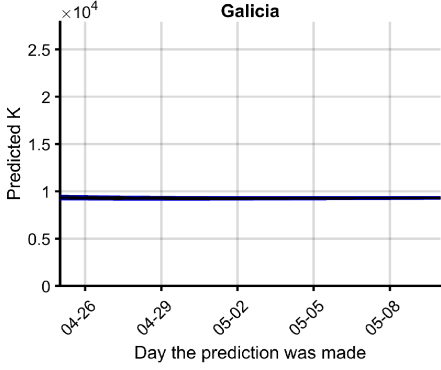
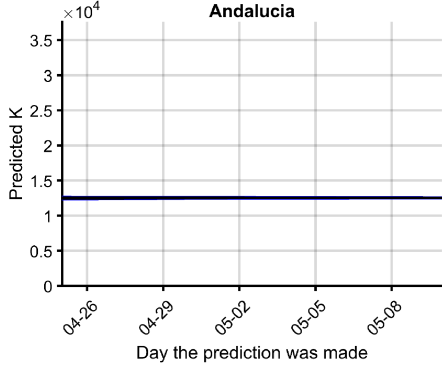
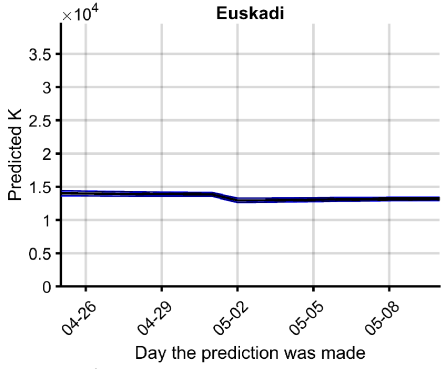
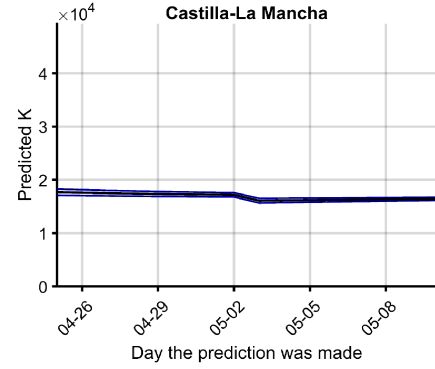
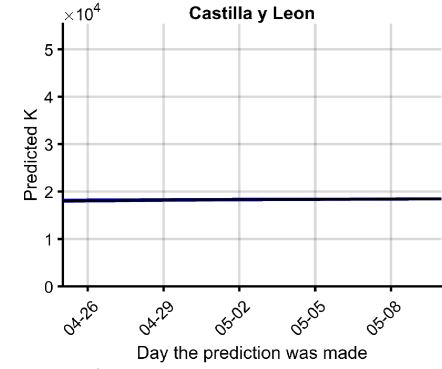
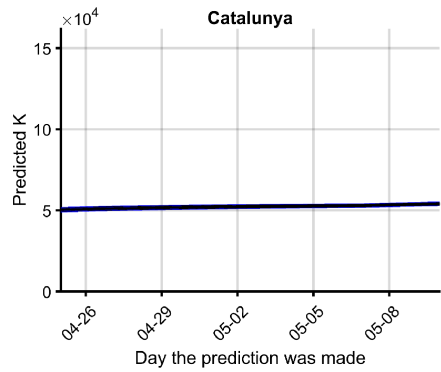
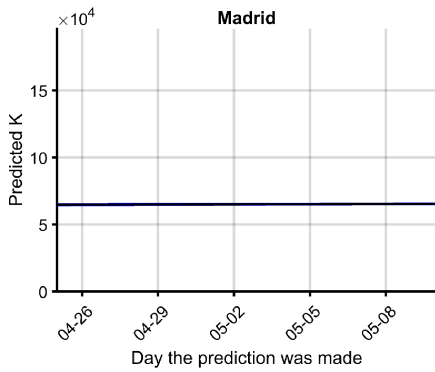
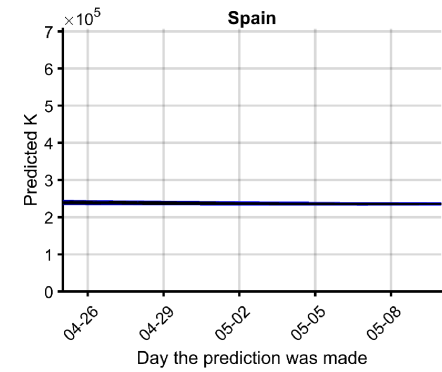
Spanish regions



2020-05-12



2020-05-11



Situation and trends in Italian and Spanish regions

Italy

Country	Reported data						Indexes		
	Cumulative cases	Attack rate / 10 ⁵ inh.	Cumulative deaths	Mortality / 10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate / 10 ⁵ inh.	$\rho_7^{(1)}$	EPG _{REP} ⁽²⁾	EPG _{EST} ⁽³⁾
Lombardia	82.904	825,6	15.116	150,5	8.556	85,2	0,94	80	1.506
Piemonte	28.889	663,1	3.428	78,7	3.439	78,9	0,62	49	585
Emilia Romagna	26.929	603,9	3.885	87,1	2.015	45,2	0,62	28	406
Veneto	18.782	382,8	1.686	34,4	1.074	21,9	0,64	14	131
Toscana	9.802	262,8	959	25,7	571	15,3	0,58	9	88
Liguria	8.863	571,6	1.301	83,9	1.091	70,4	0,63	44	667
Lazio	7.212	122,7	566	9,6	745	12,7	0,75	10	78
Marche	6.568	430,6	969	63,5	393	25,8	0,91	23	353
Campania	4.615	79,5	393	6,8	235	4,1	0,81	3	29
Puglia	4.337	107,6	456	11,3	357	8,9	1,13	10	106
Trento	4.303	401,3	445	41,5	278	25,9	0,25	7	136
Sicilia	3.343	66,9	261	5,2	223	4,5	0,65	3	24
Friuli Venezia Giulia	3.148	259,0	313	25,8	153	12,6	0,76	10	100
Abruzzo	3.115	237,5	370	28,2	216	16,5	0,83	14	166
Bolzano	2.572	2.394,0	290	269,9	74	68,9	1,18	81	187
Umbria	1.419	160,9	71	8,0	40	4,5	1,87	8	NA
Sardegna	1.344	82,0	120	7,3	59	3,6	1,99	7	64
Valle d'Aosta	1.160	923,5	140	111,5	41	32,6	0,85	28	343
Calabria	1.138	58,4	93	4,8	41	2,1	0,98	2	NA
Basilicata	387	68,8	27	4,8	21	3,7	NA	NA	NA
Molise	386	126,3	22	7,2	89	29,1	3,14	92	NA

Scale									
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	200	2000
Best	Best	Best	Best	Best	Best	Best	0,0	0	0

Spain

Autonomous regions	Reported data						Indexes		
	Cumulative cases	Attack rate /10 ⁵ inh.	Cumulated deaths	Mortality rate /10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate /10 ⁵ inh.	$\rho_7^{(1)}$	EPG _{REP} ⁽²⁾	EPG _{EST} ⁽³⁾
Madrid	64.972	978,4	8.720	131,3	2.896	43,6	1,00	44	592
Catalunya	55.144	728,9	5.621	74,3	NA	NA	NA	NA	NA
Castilla y Leon	18.048	749,5	1.914	79,5	1.459	60,6	0,84	51	559
Castilla-La Mancha	16.431	807,2	2.811	138,1	725	35,6	1,0	35	604
Euskadi	13.176	604,9	1.429	65,6	612	28,1	0,73	21	223
Andalucia	12.293	145,9	1.326	15,7	380	4,5	1,13	5	55
Comunitat Valenciana	10.740	215,9	1.336	26,9	536	10,8	1,01	11	135
Galicia	9.291	344,1	595	22,0	642	23,8	0,65	16	105
Aragon	5.359	405,7	828	62,7	355	26,9	0,83	22	350
Navarra	5.081	781,7	493	75,9	322	49,5	0,89	44	440
La Rioja	4.008	1.278,1	347	110,7	111	35,4	0,70	25	215
Extremadura	2.919	274,0	487	45,7	168	15,8	0,75	12	198
Asturias	2.351	230,0	304	29,7	79	7,7	1,98	15	191
Canarias	2.268	102,8	151	6,8	81	3,7	1,16	4	29
Cantabria	2.246	386,1	203	34,9	131	22,5	1,20	27	238
Baleares	1.953	164,4	210	17,7	83	7,0	1,22	9	98
Murcia	1.517	102,0	139	9,3	42	2,8	1,34	4	34
Melilla	119	140,5	2	2,4	5	5,9	NA	NA	NA
Ceuta	114	134,4	4	4,7	14	16,5	NA	NA	NA

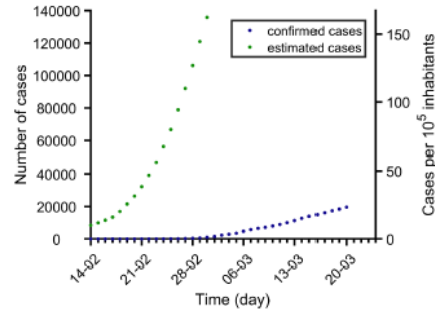
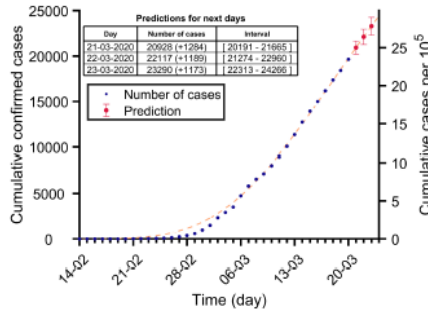
Scale									
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	200	2000
Best	Best	Best	Best	Best	Best	Best	0,0	0	0

⁽¹⁾ ρ_7 is the average of 7 consecutive ρ , but can still fluctuate. ⁽²⁾ EPG stands for Effective Growth Potential. EPG_{REP} is obtained by multiplying attack rate of last 14 days per 10⁵ inhabitants (i.e. density of cases) by ρ_7 (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG_{EST} is obtained by multiplying estimated real attack rate of last 14 days per 10⁵ inhabitants by ρ_7 .

Legend: Countries' reports details

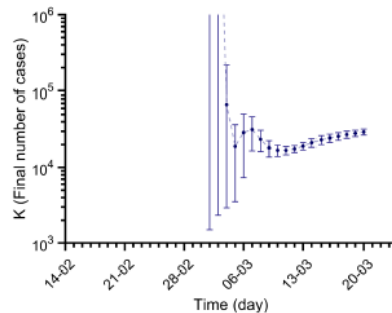
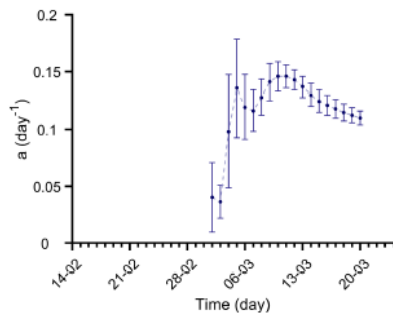
Iran 20-03-2020. Population: 83.7M. Current cumulated incidence: 23/10⁵

Confirmed cases:
data (blue),
model fitted
(dashed line),
predictions (red
points and table)



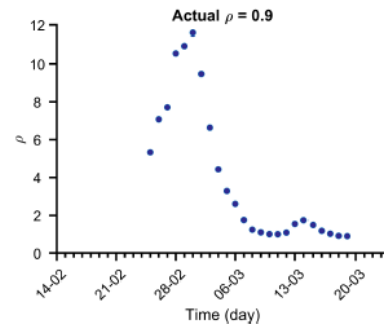
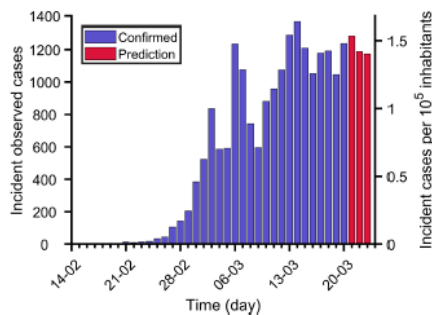
Estimated
cases using
death rate (see
Methods)

Fitted a value
using points
prior to each
date



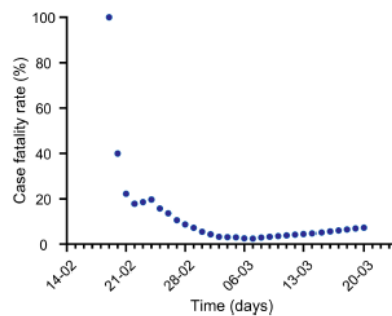
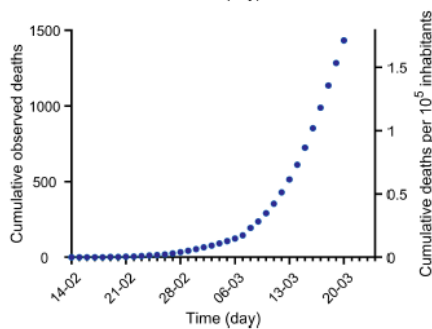
Fitted K value
using points
prior to each
date

Reported
and
predicted
new cases



Evolution of ρ , a
parameter related
with Reproduction
number (see
Methods)

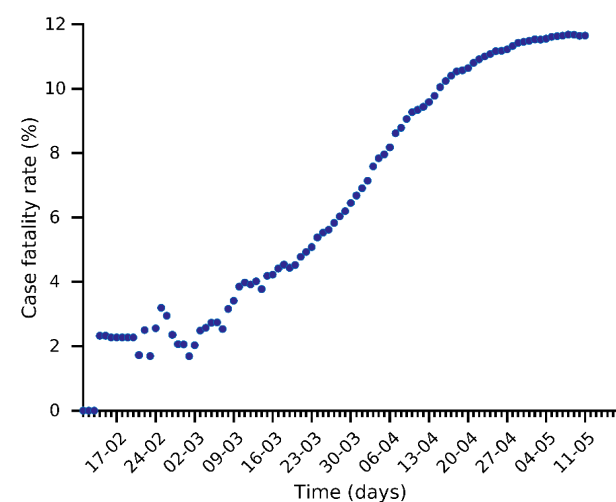
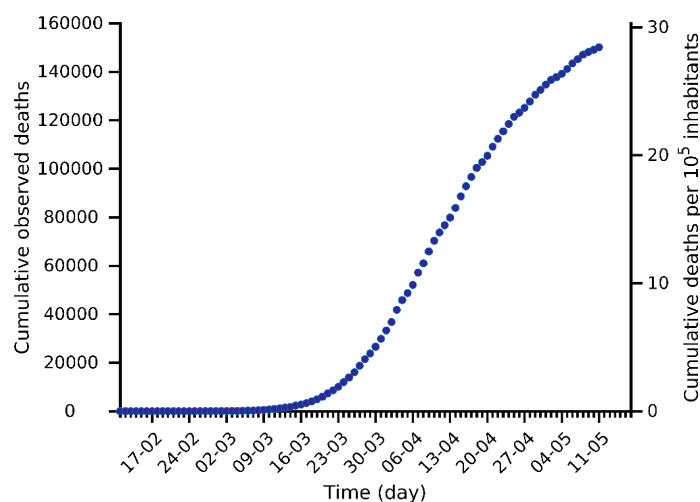
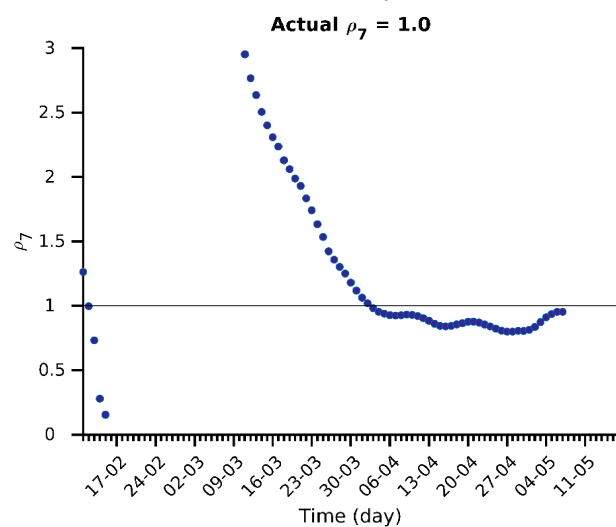
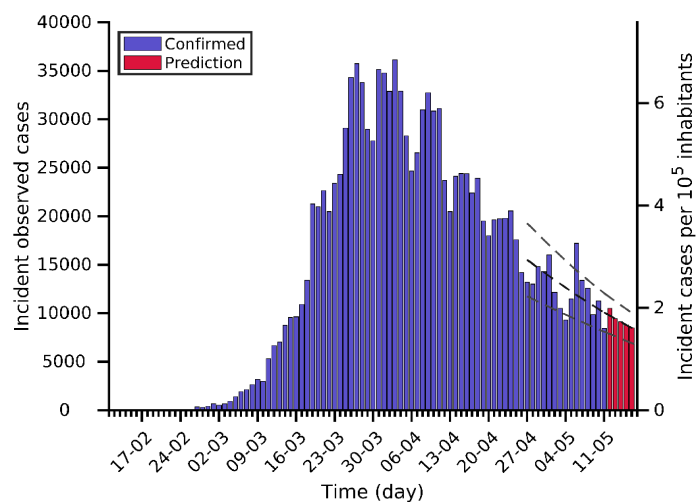
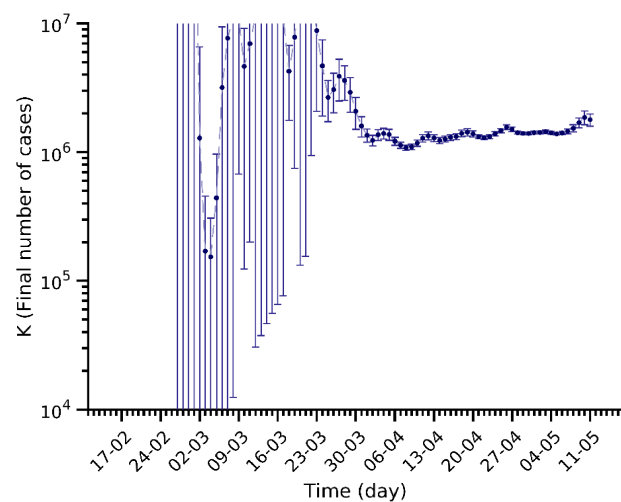
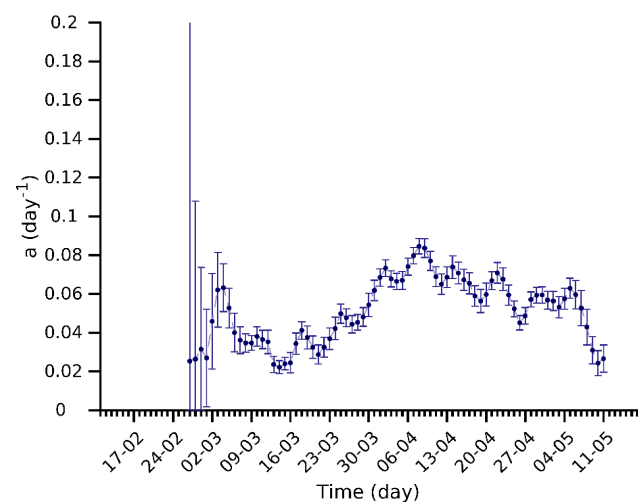
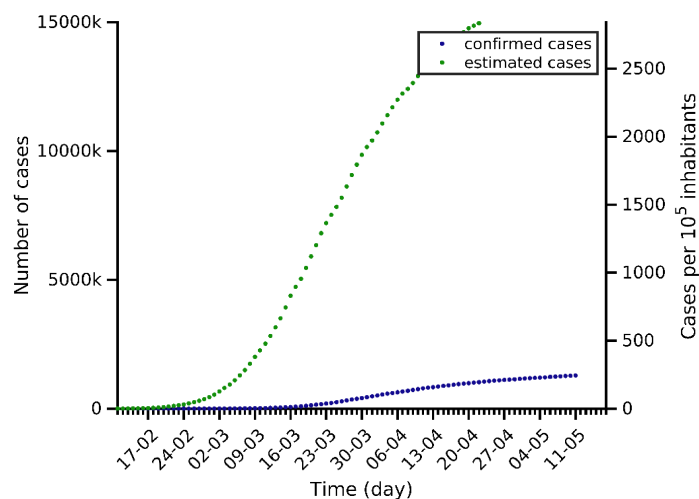
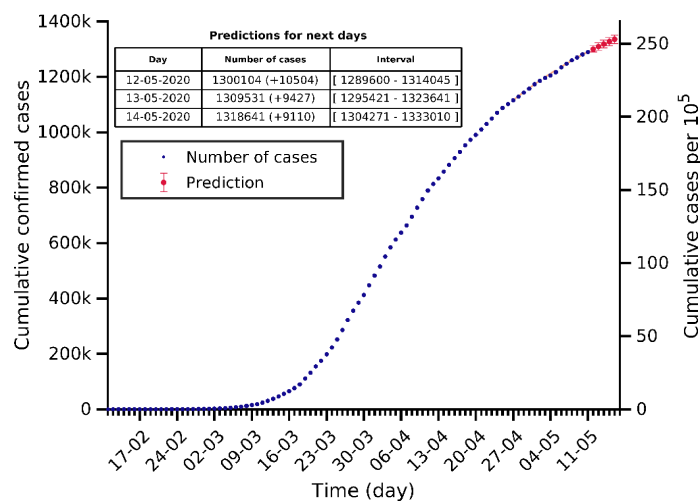
Reported
deaths



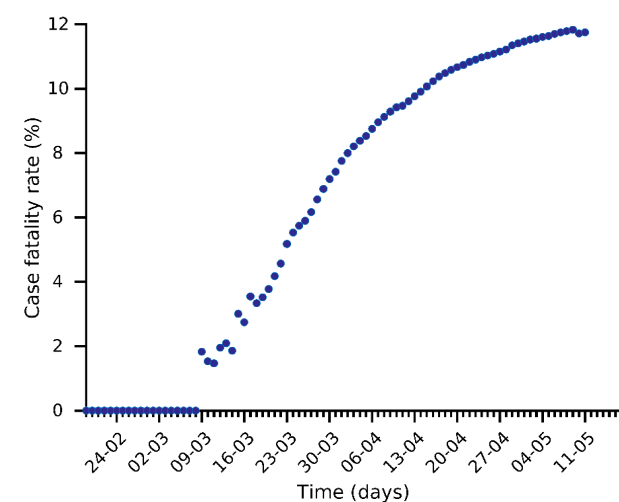
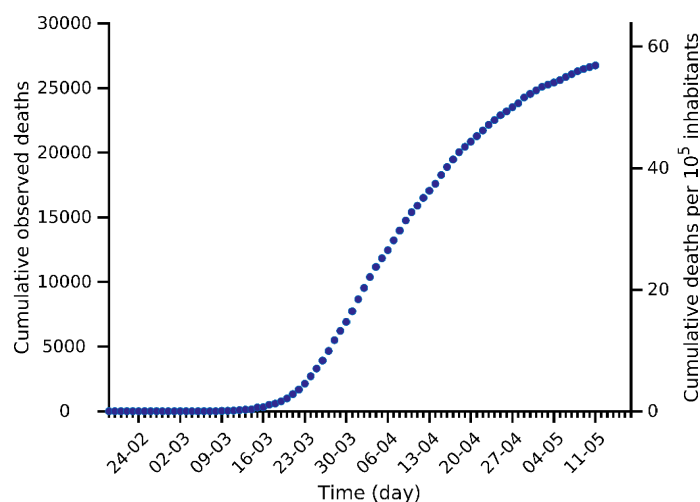
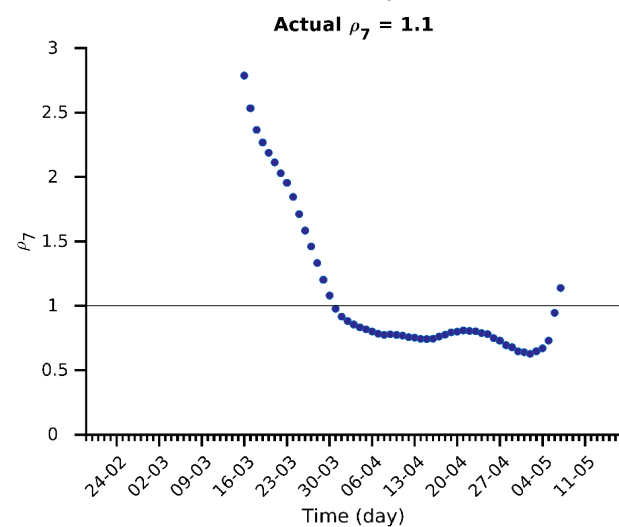
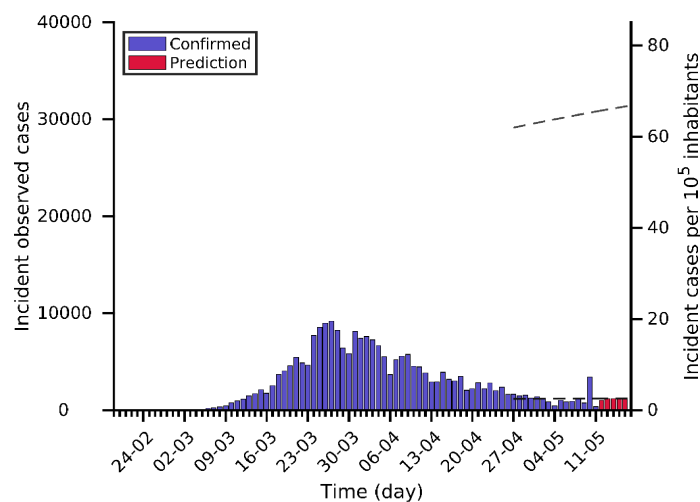
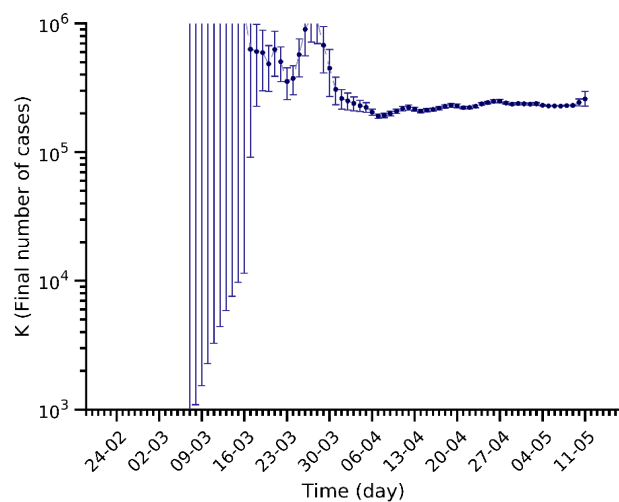
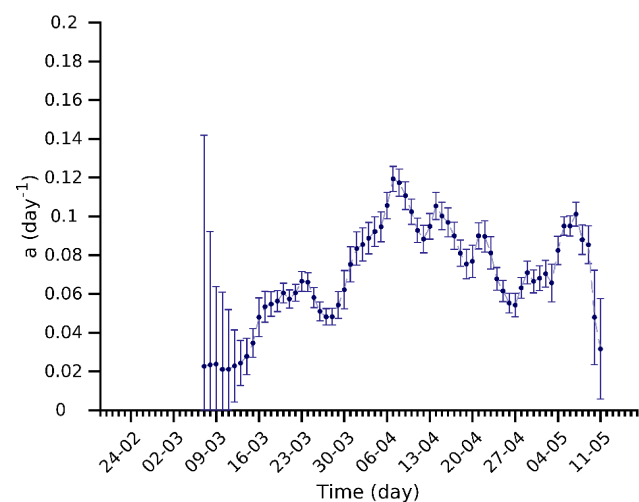
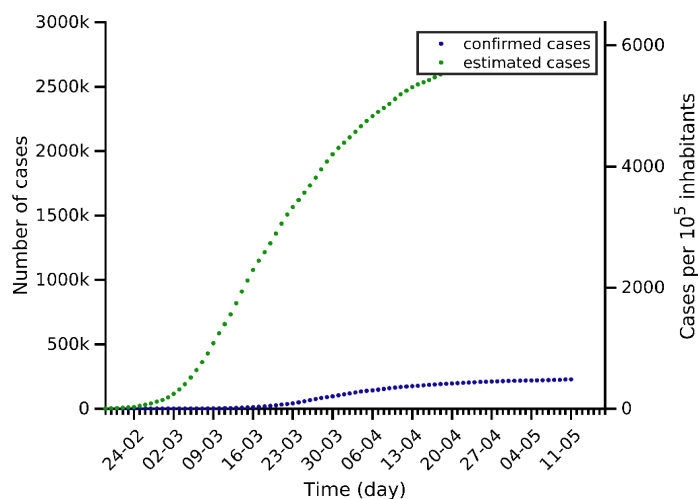
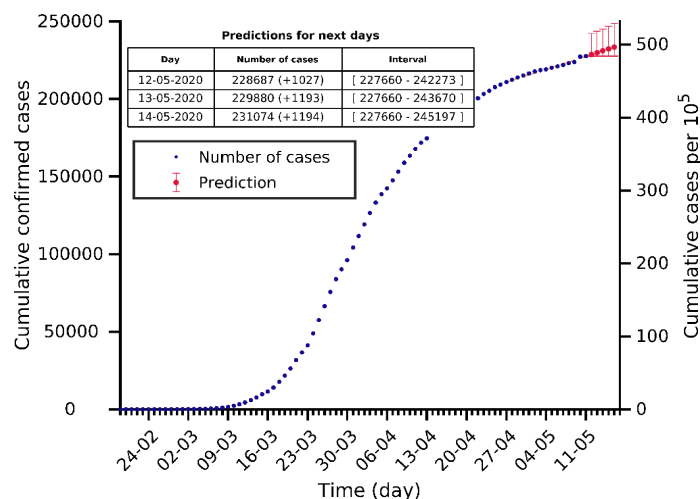
Deaths /
cumulated
reported cases

(1) Analysis and prediction of COVID-19 for EU+EFTA+UK

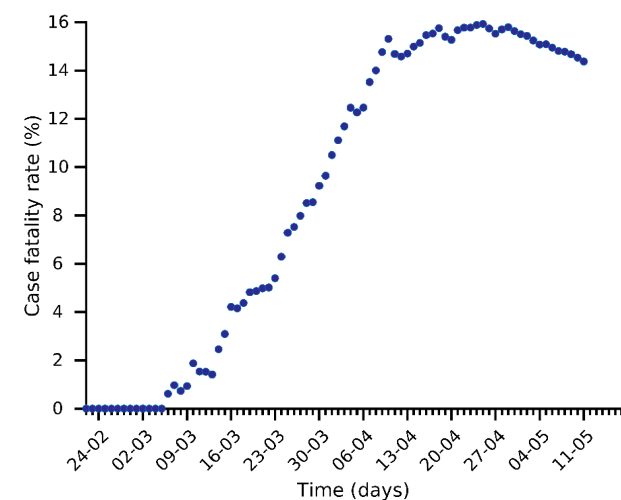
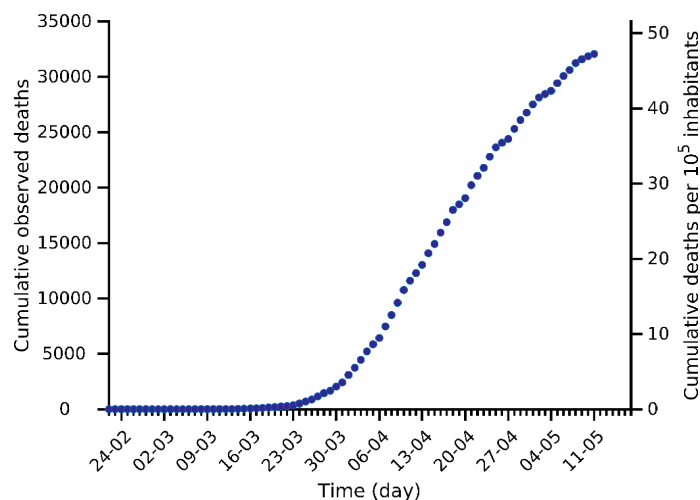
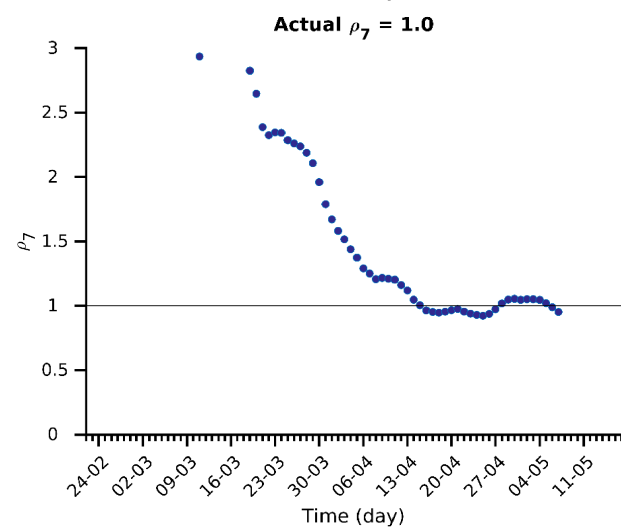
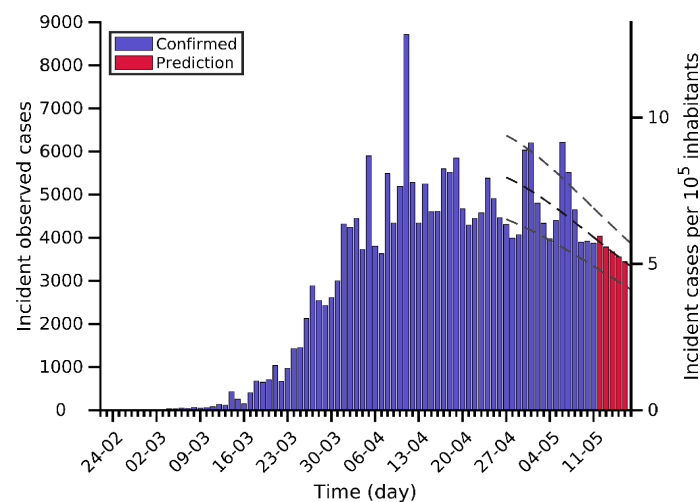
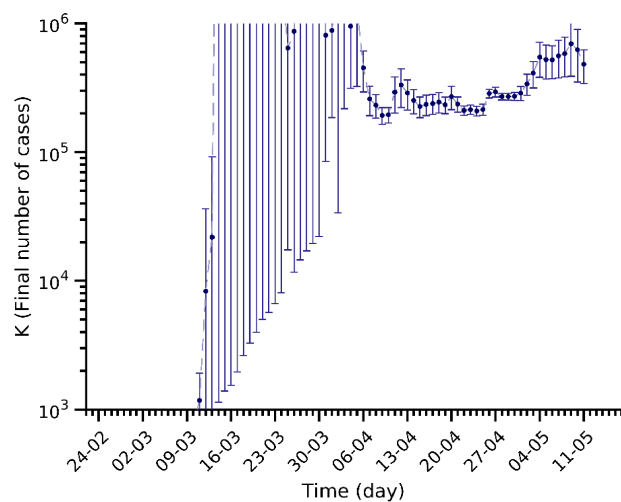
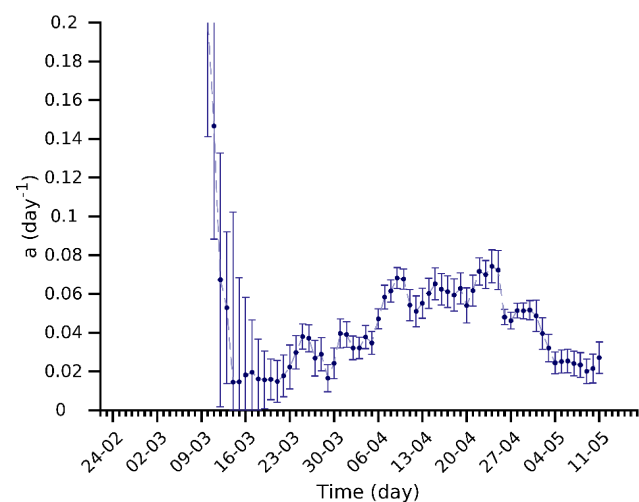
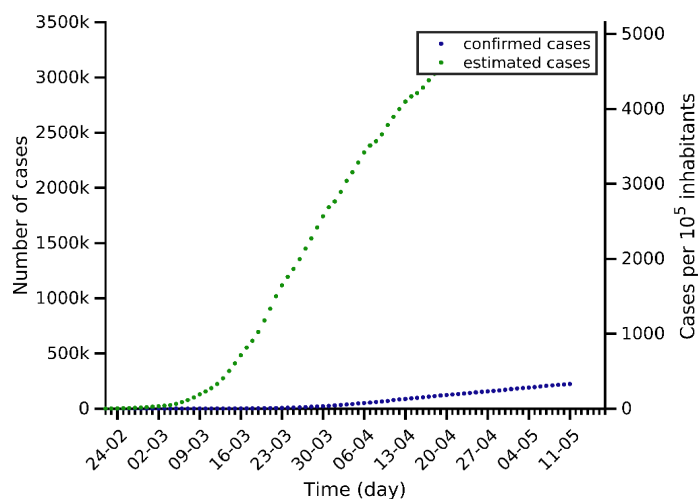
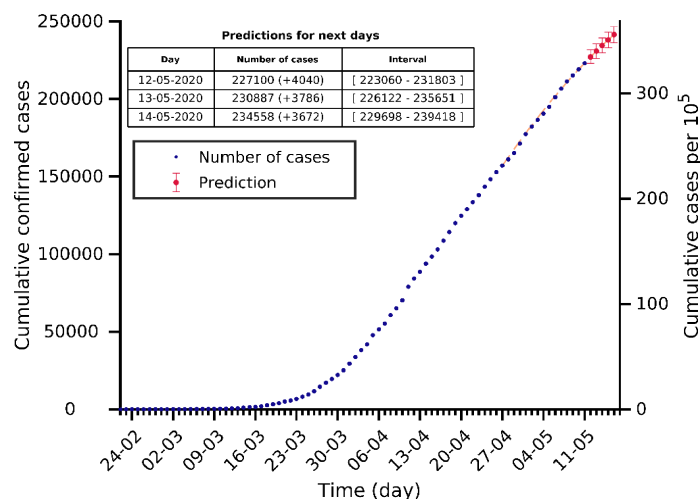
Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>



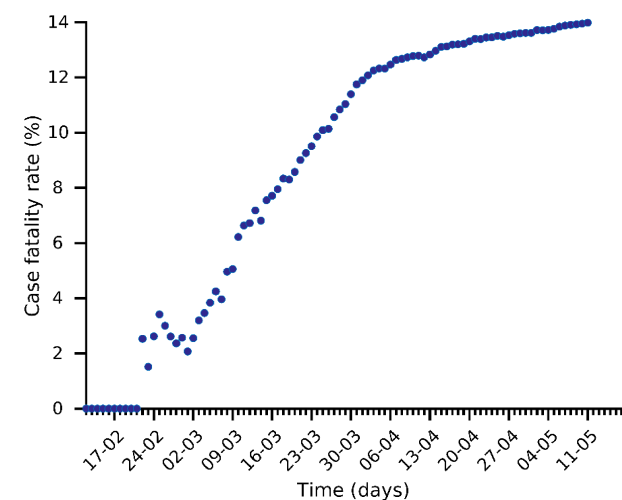
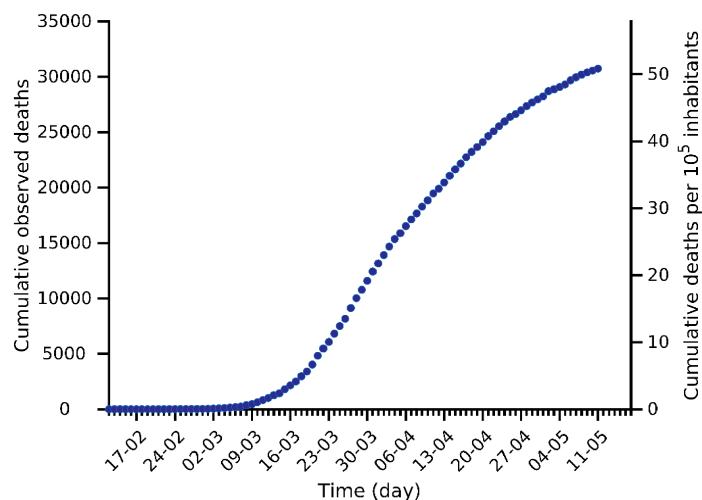
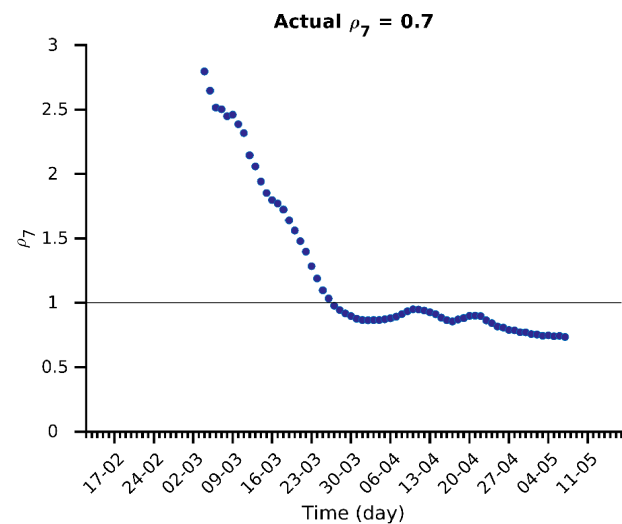
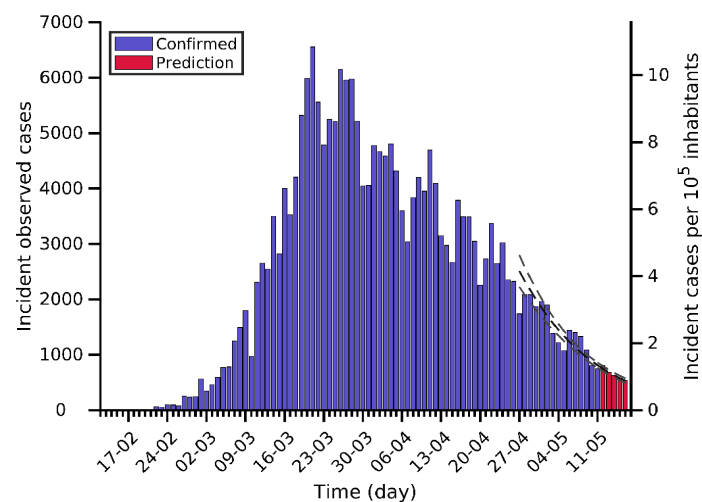
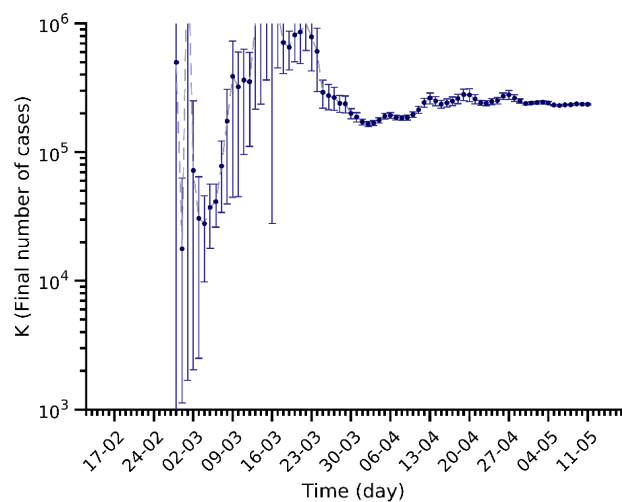
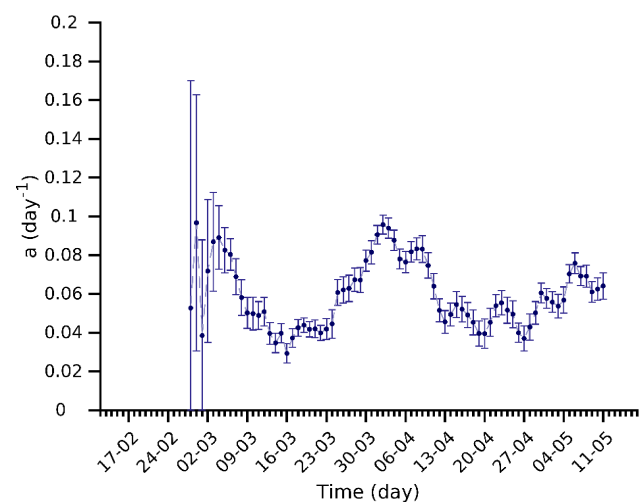
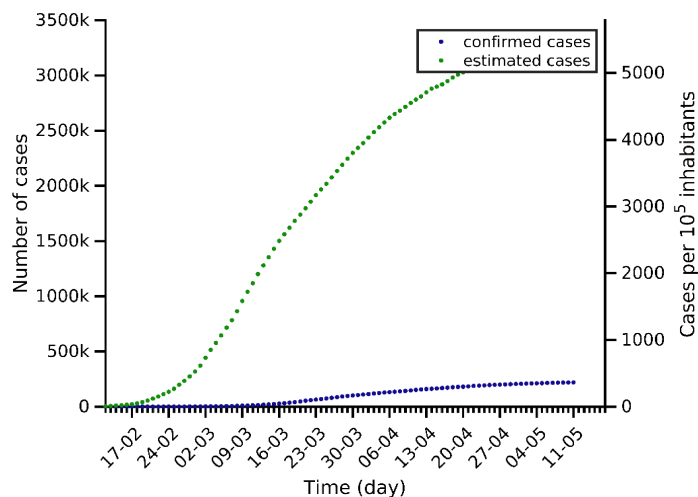
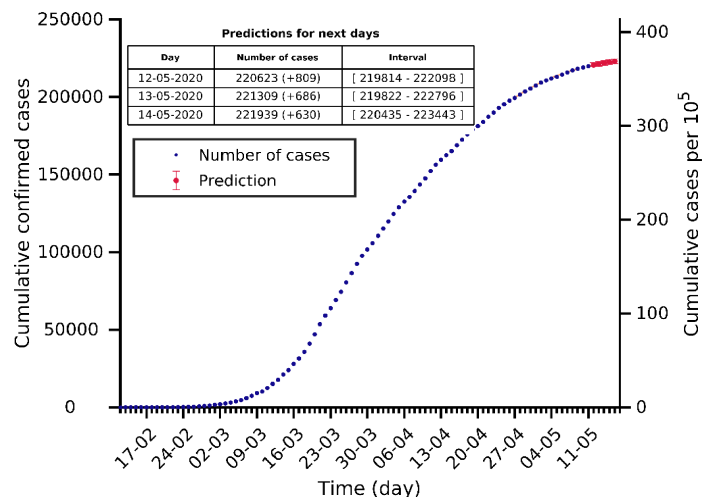
Spain 11-05-2020. Population: 47.0M. Current cumulated incidence: 484/10⁵



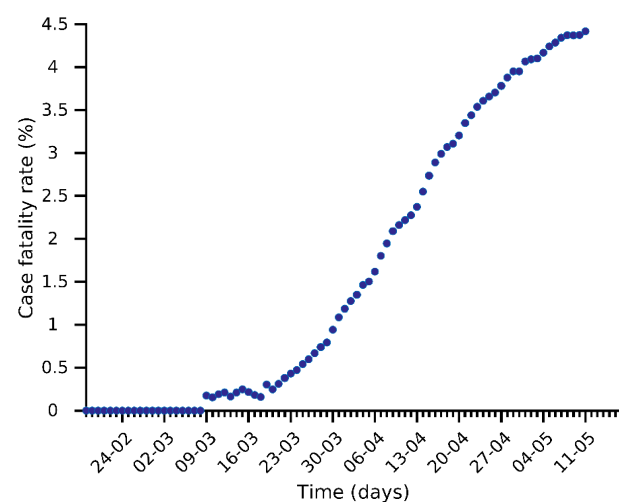
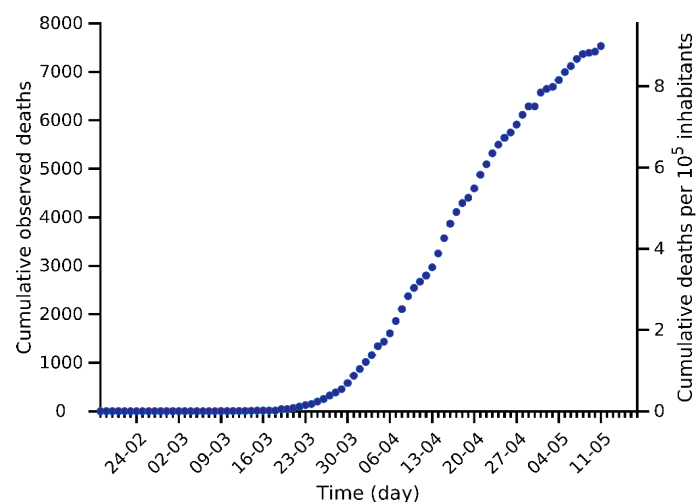
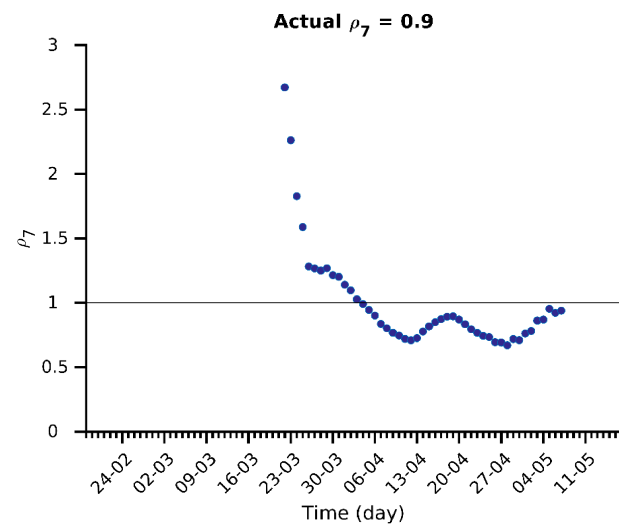
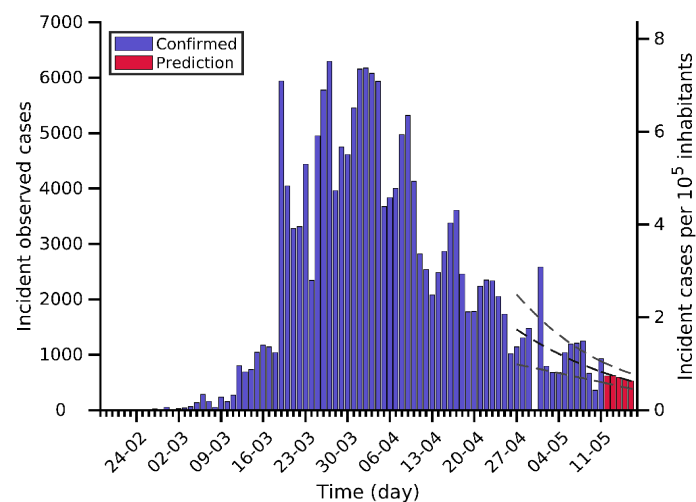
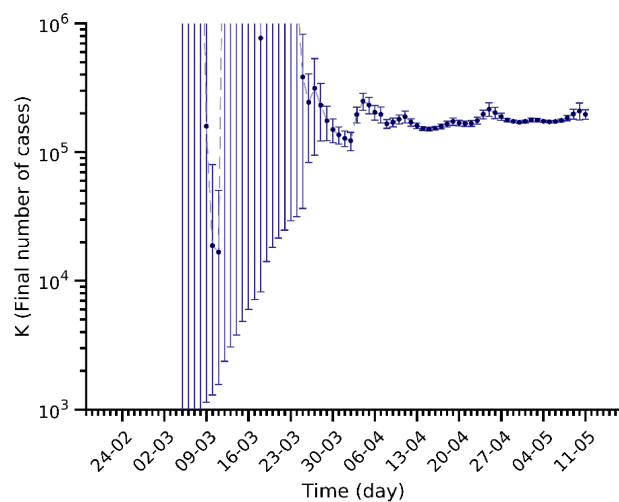
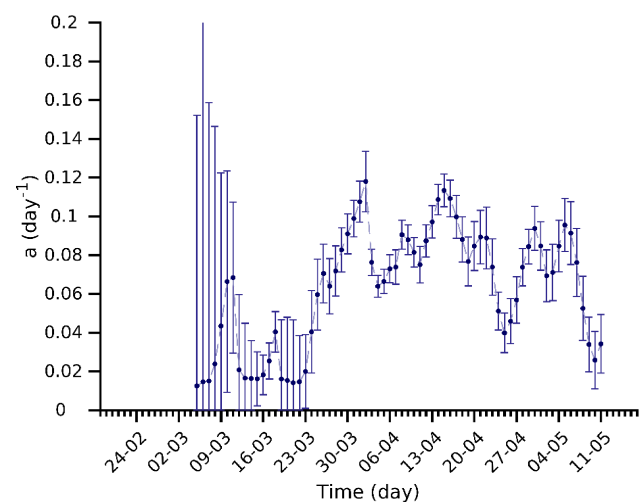
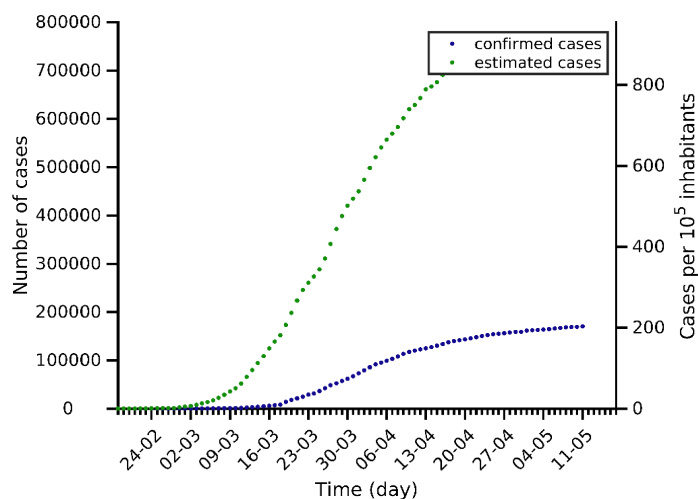
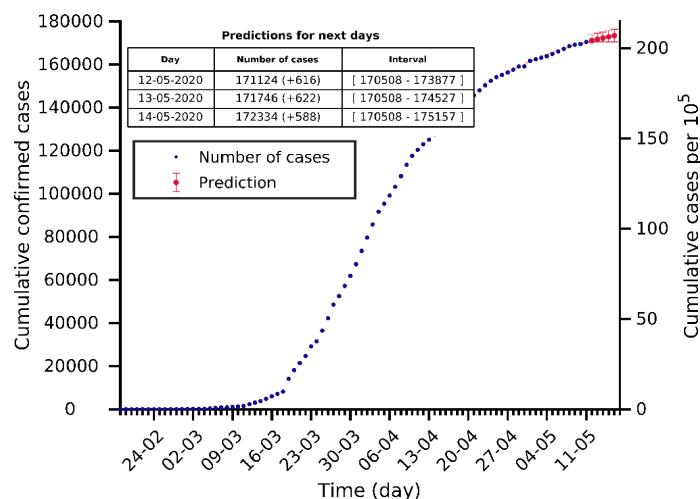
UK 11-05-2020. Population: 67.9M. Current cumulated incidence: 329/10⁵



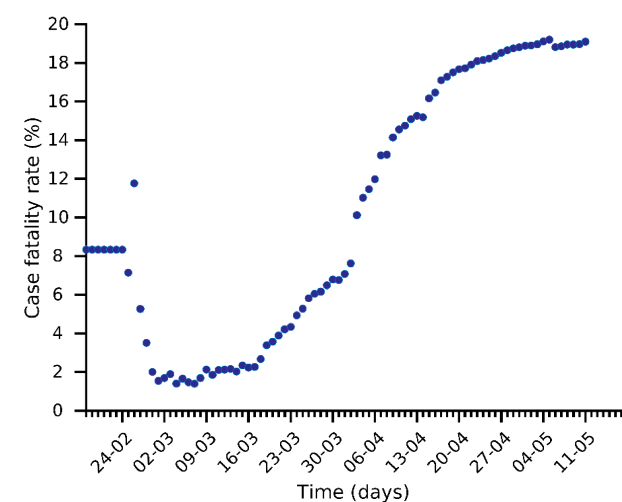
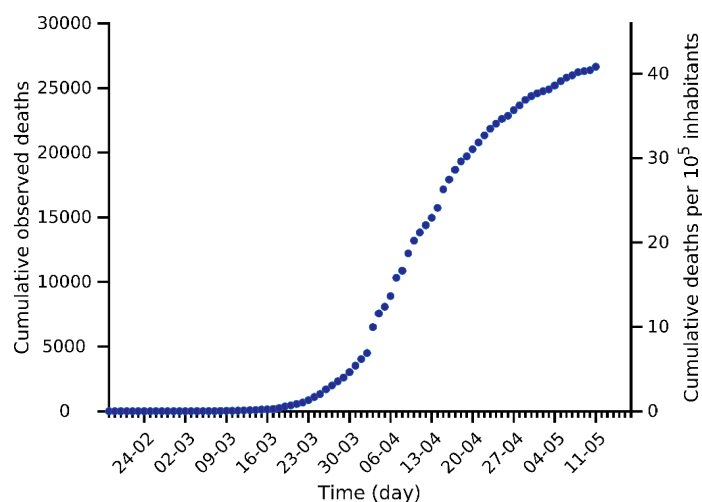
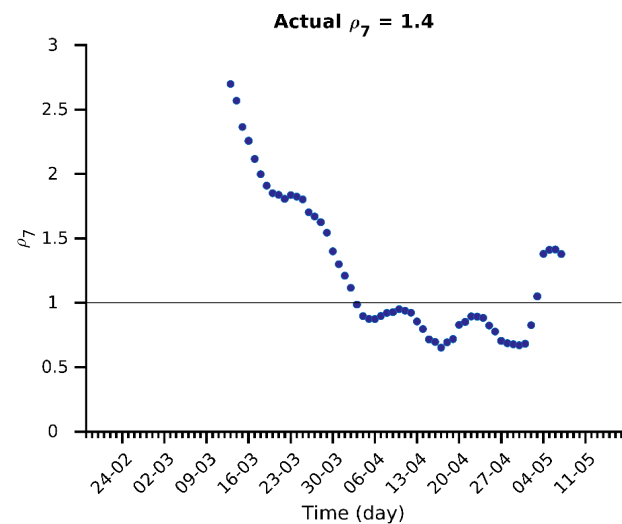
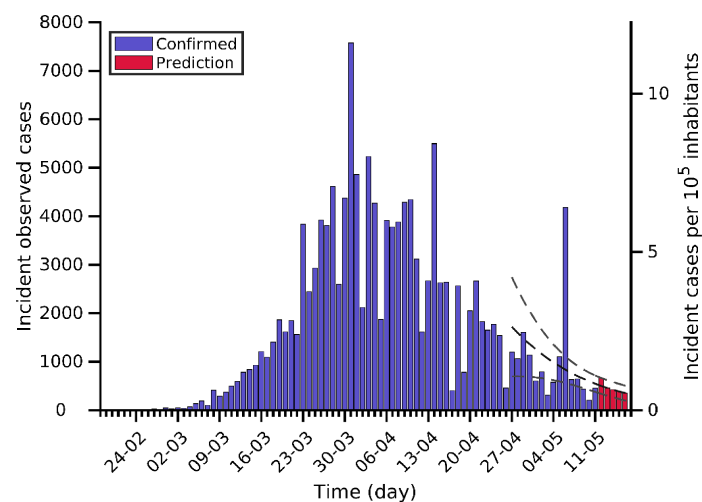
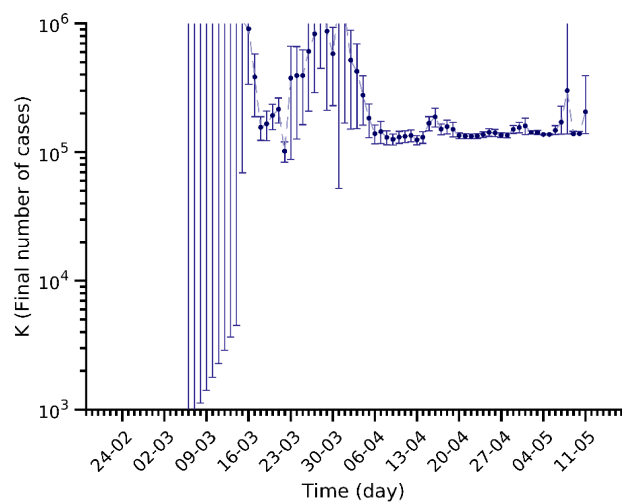
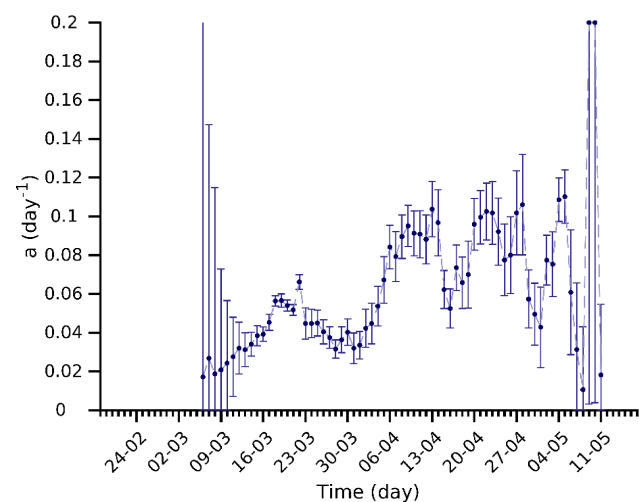
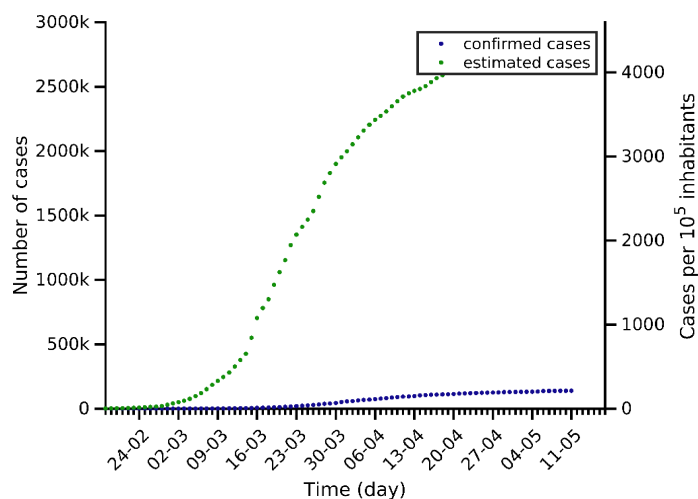
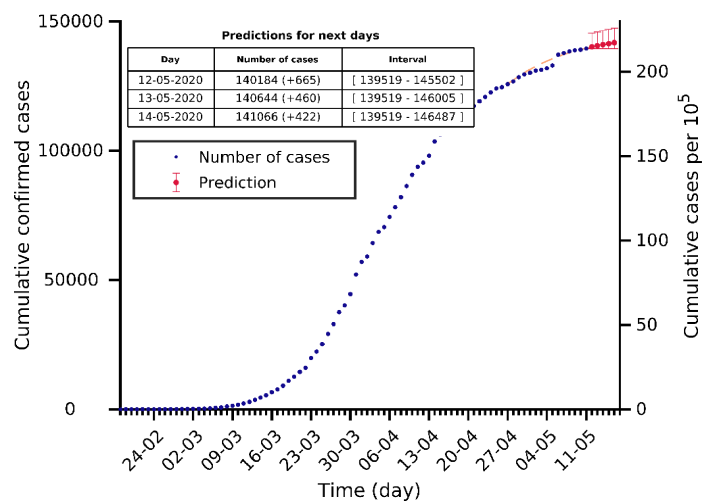
Italy 11-05-2020. Population: 60.5M. Current cumulated incidence: 364/10⁵



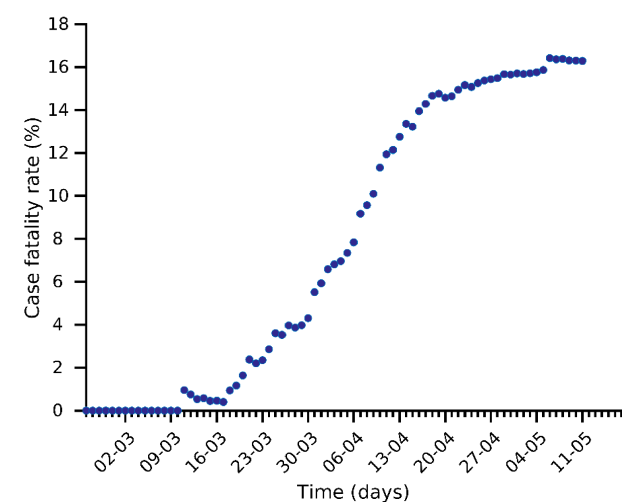
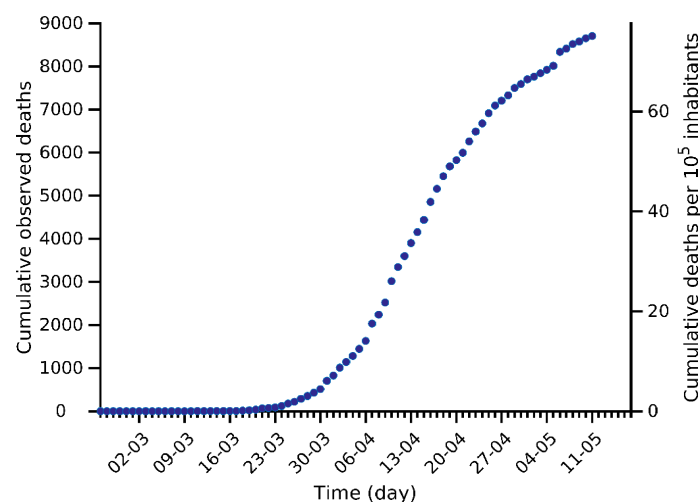
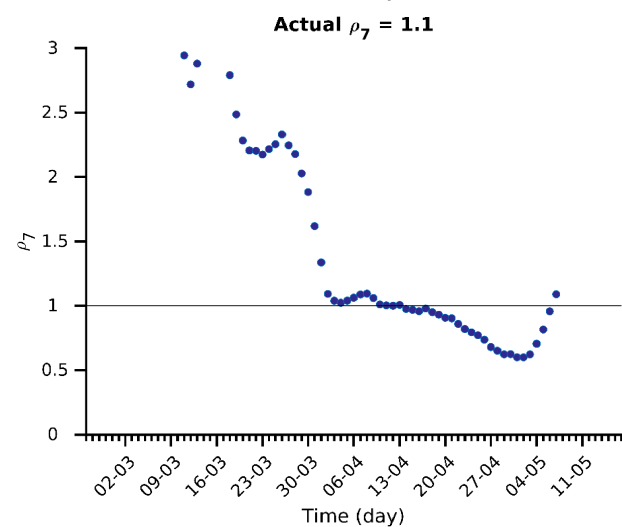
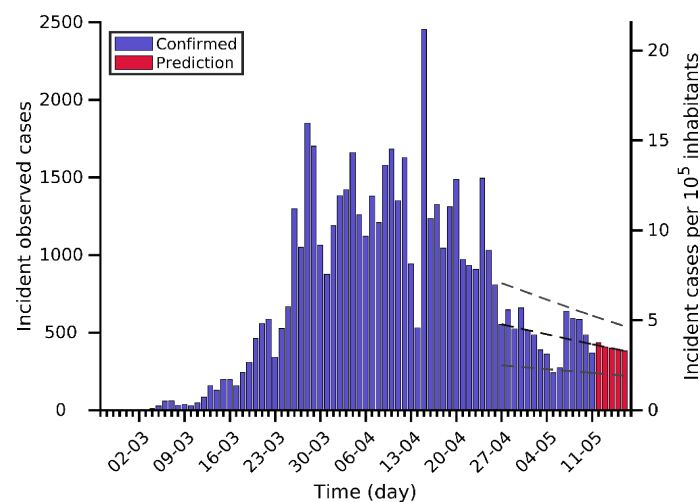
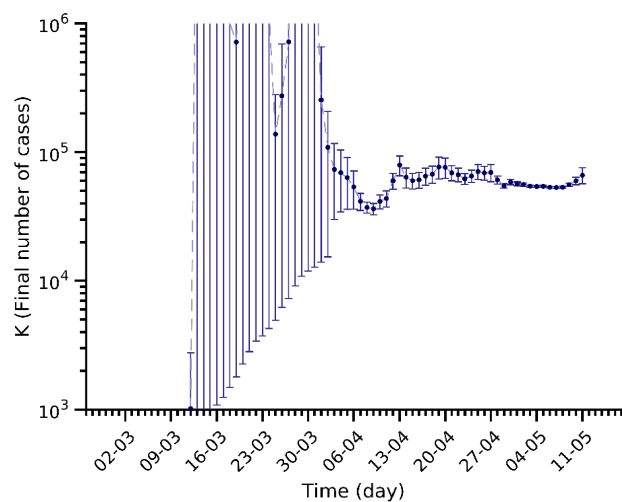
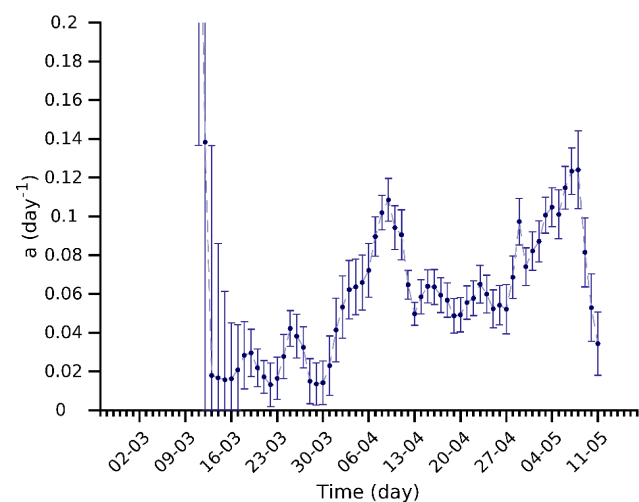
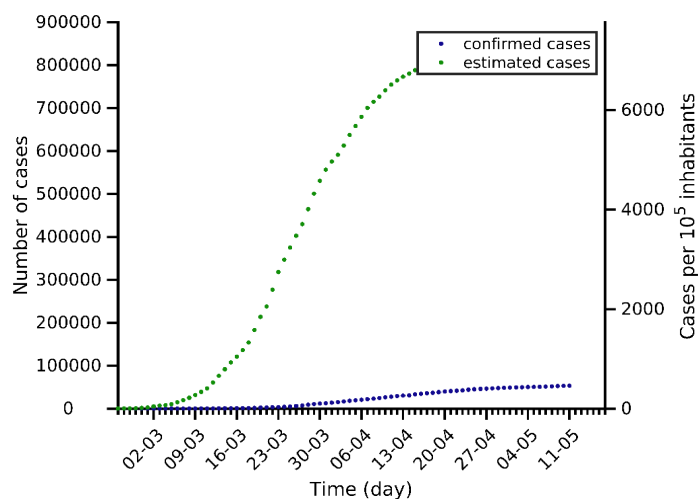
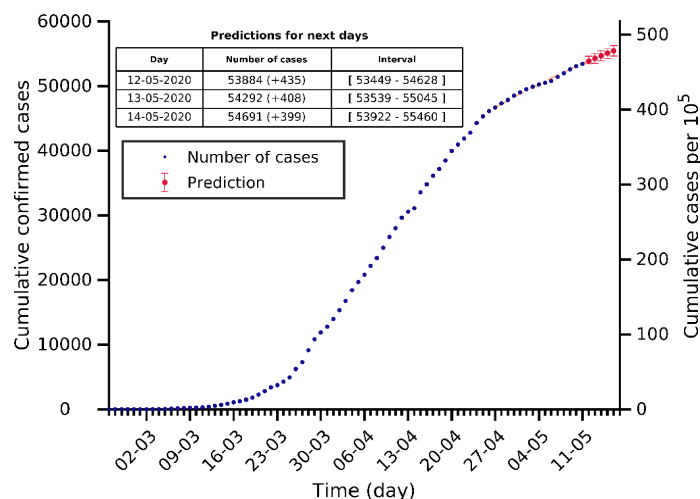
Germany 11-05-2020. Population: 83.8M. Current cumulated incidence: 204/10⁵



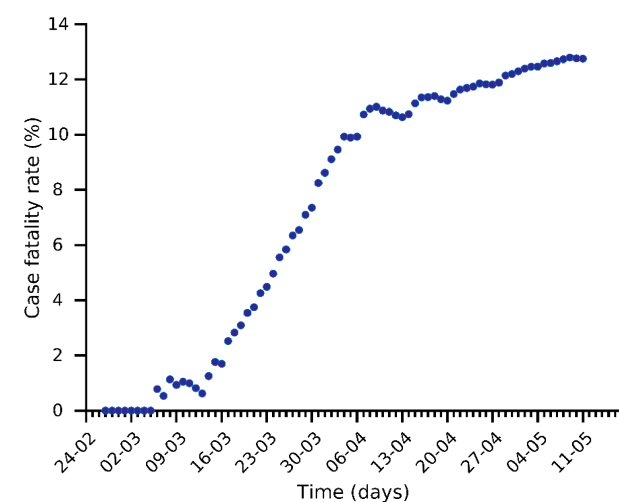
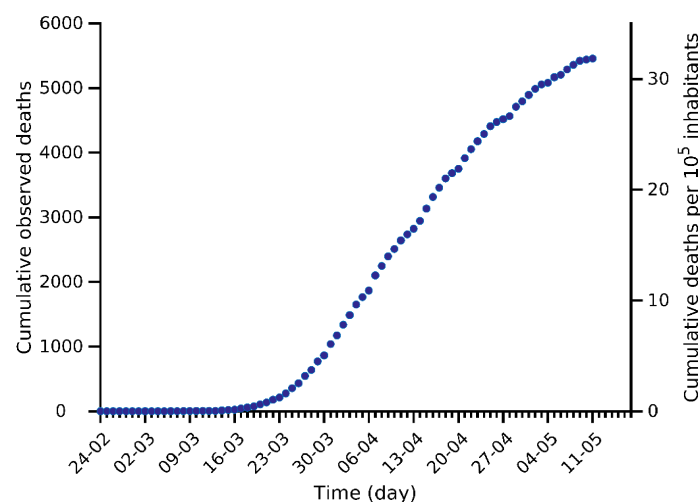
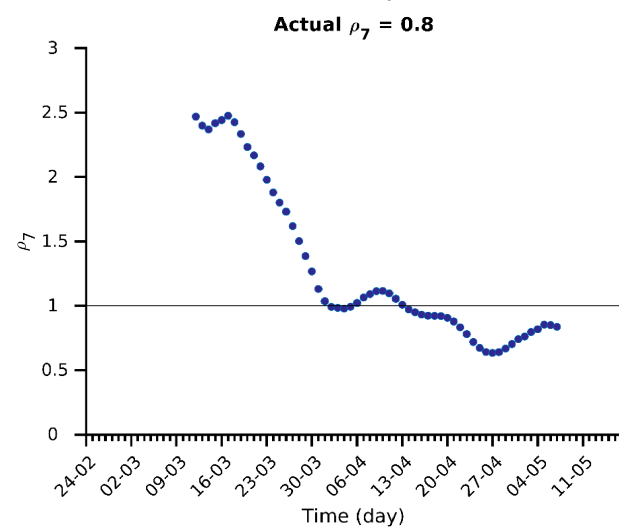
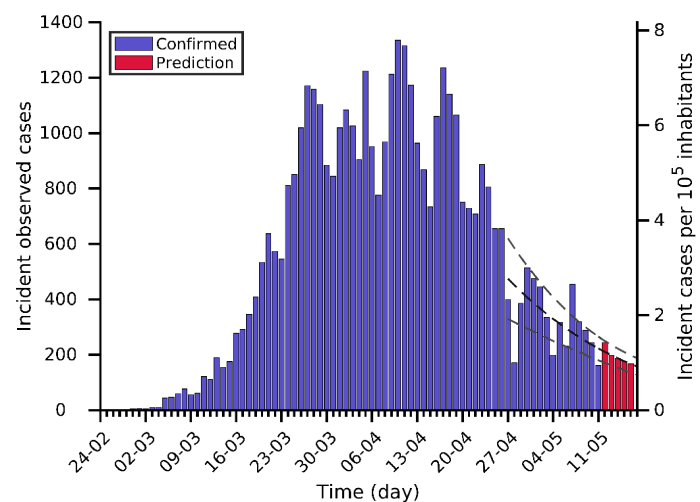
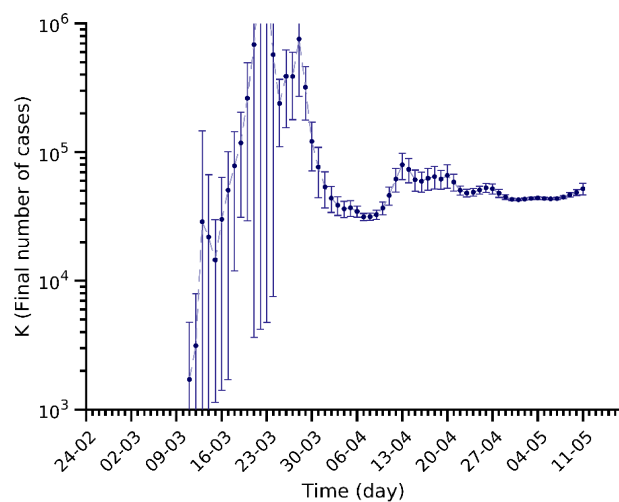
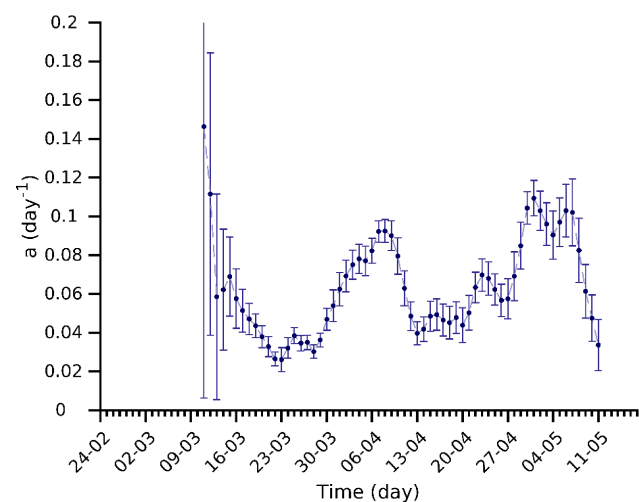
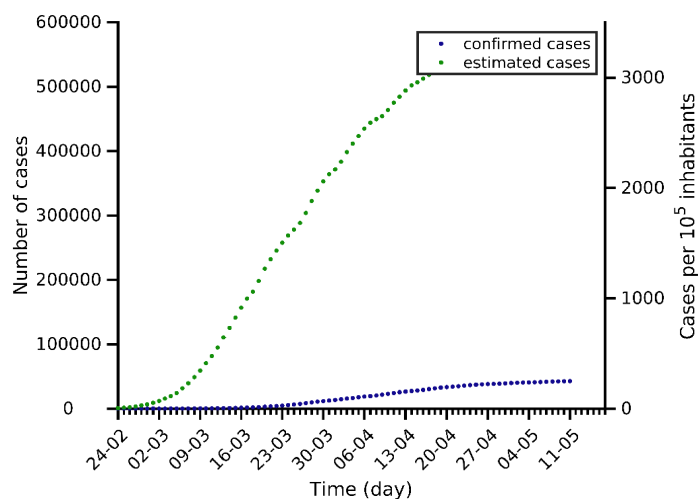
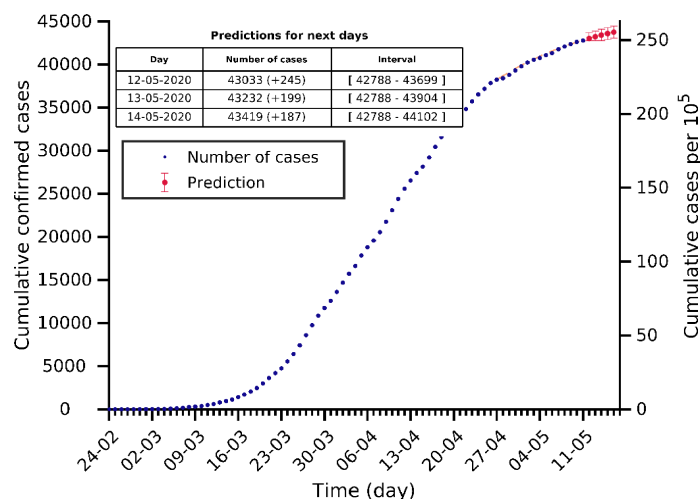
France 11-05-2020. Population: 65.3M. Current cumulated incidence: 214/10⁵



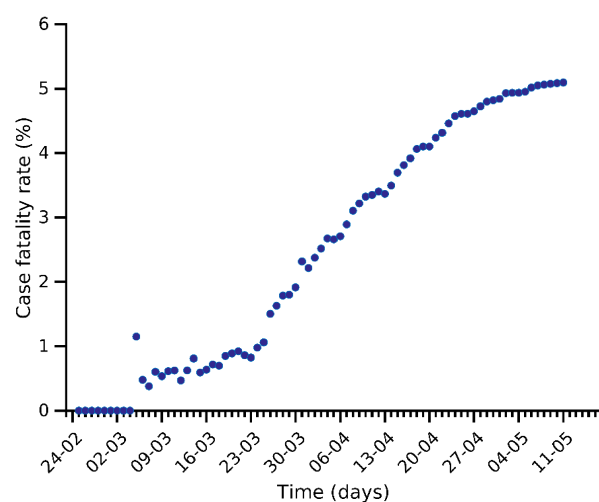
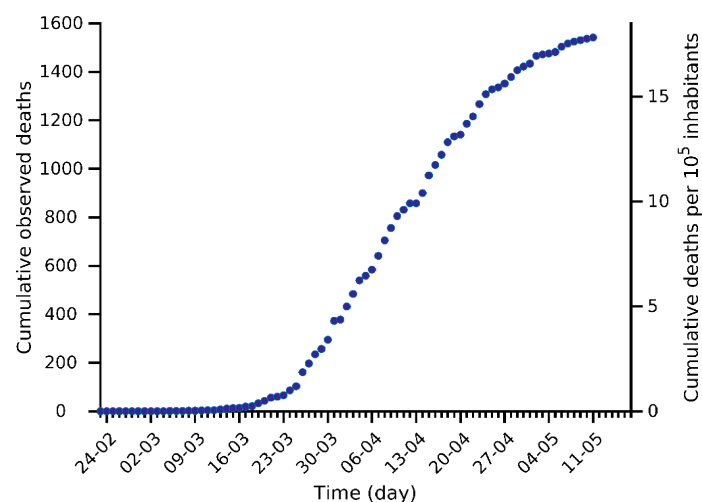
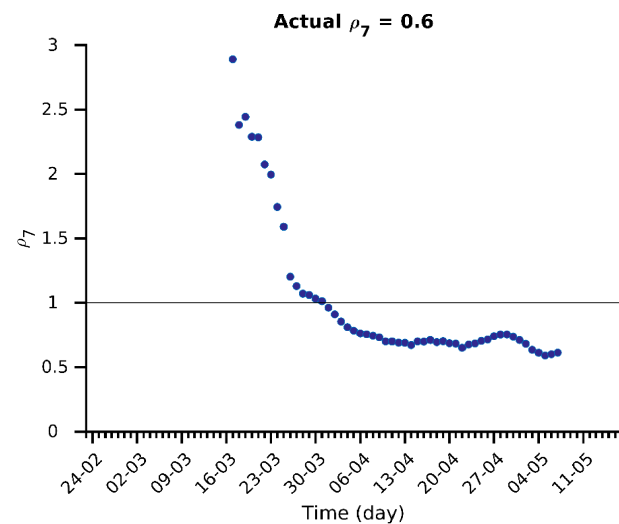
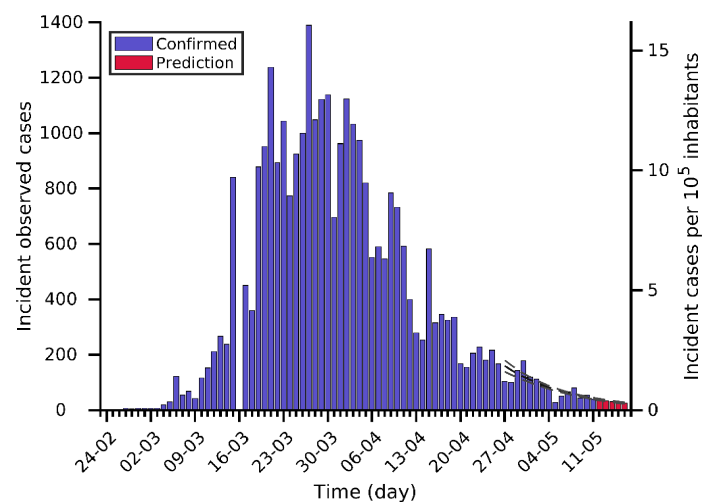
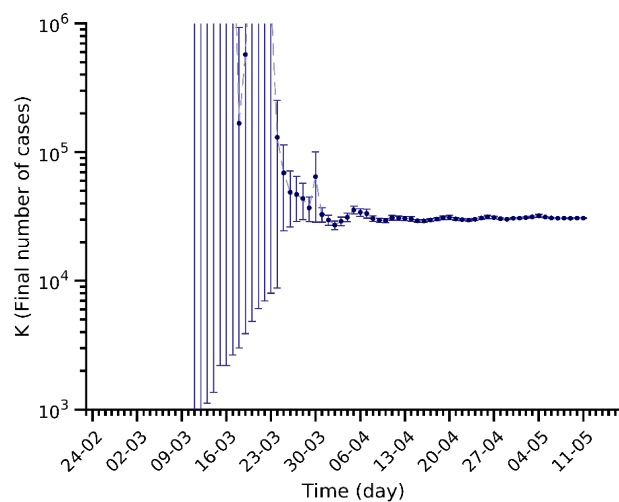
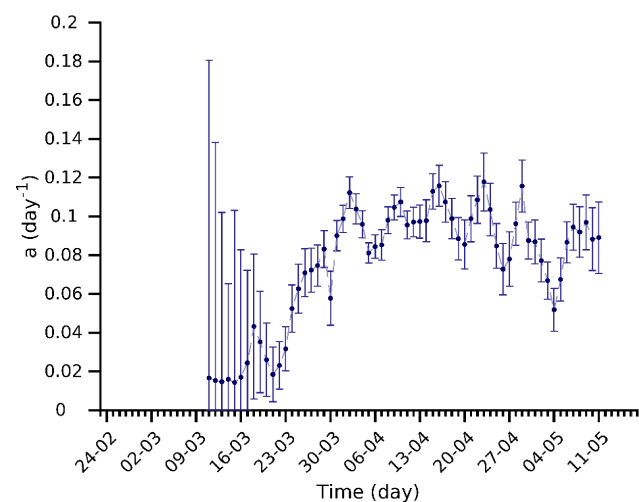
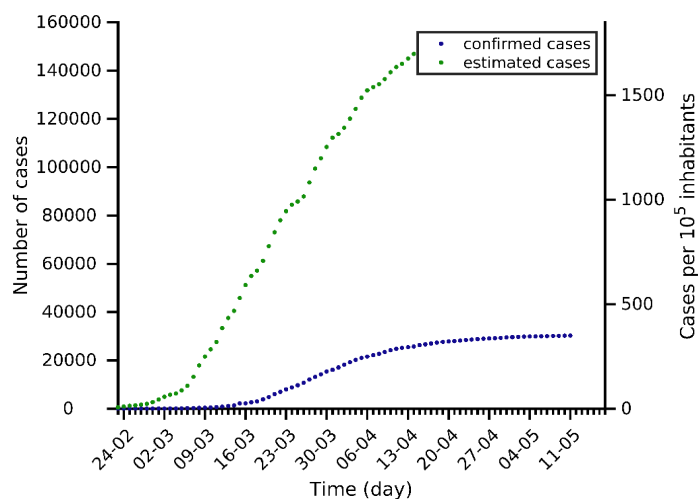
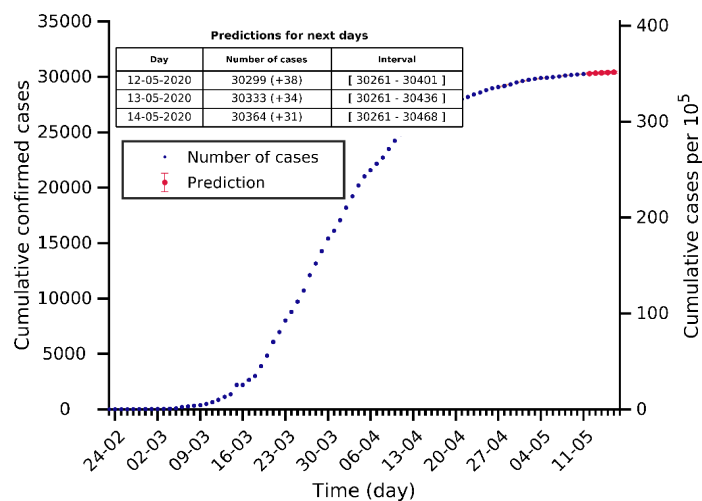
Belgium 11-05-2020. Population: 11.6M. Current cumulated incidence: 461/10⁵



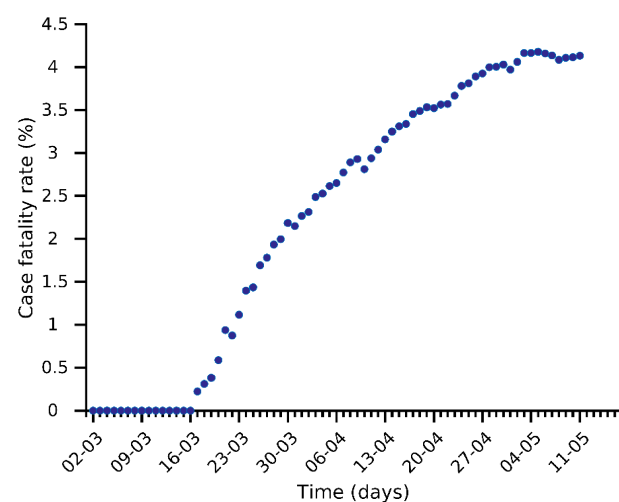
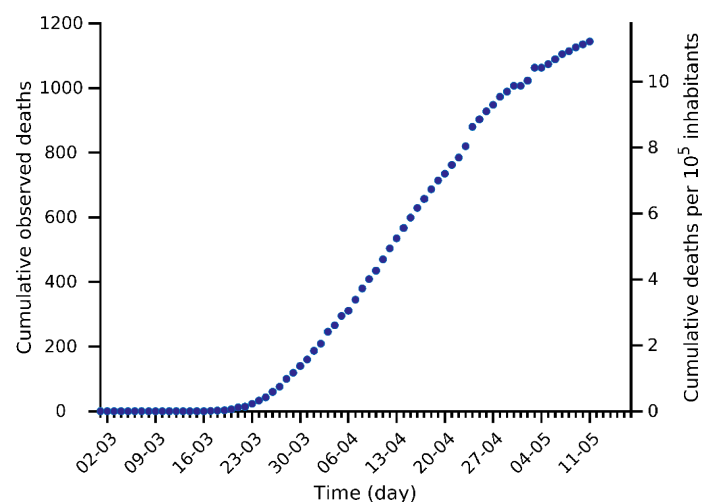
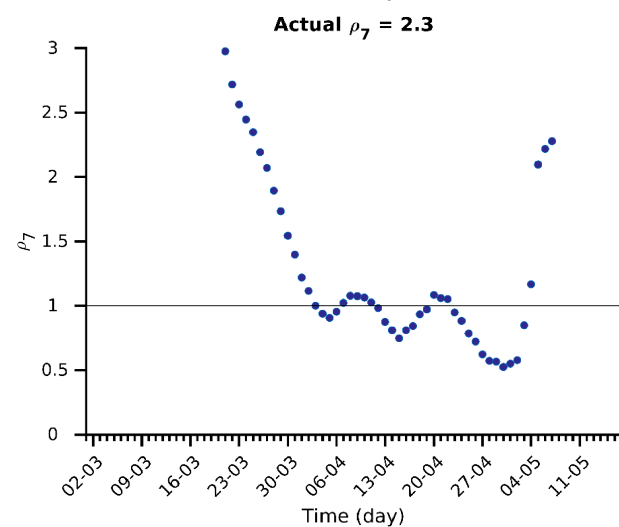
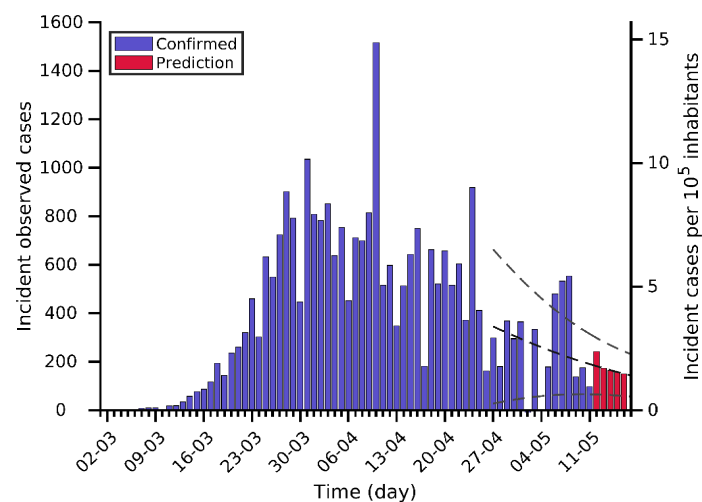
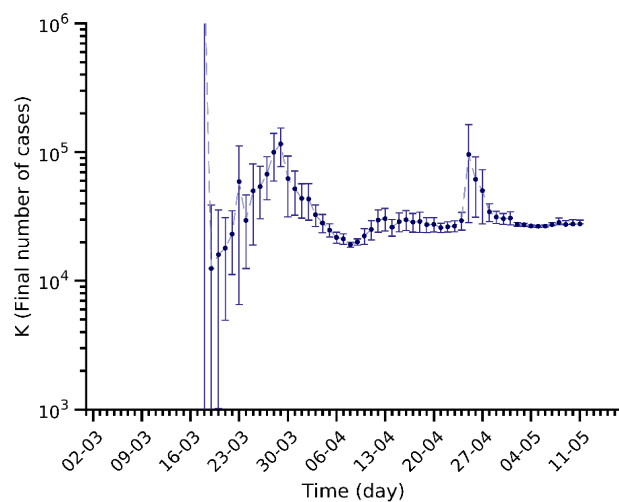
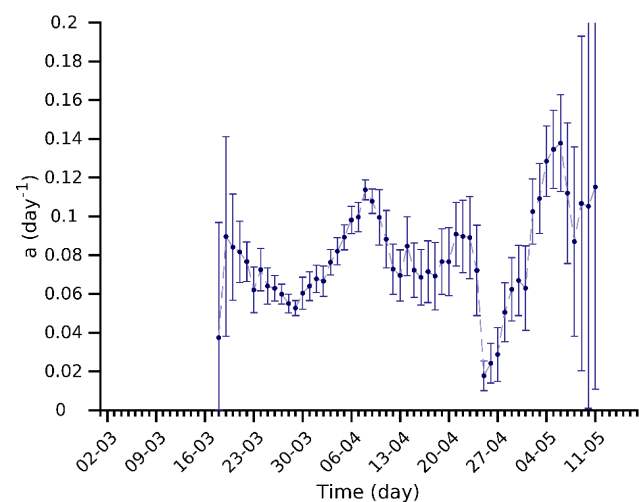
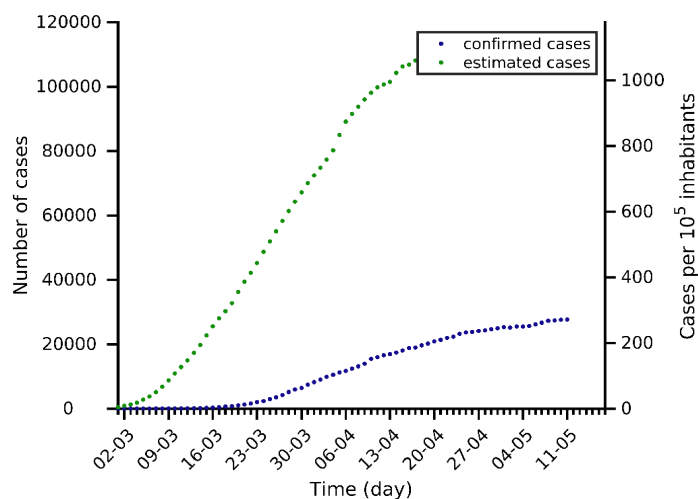
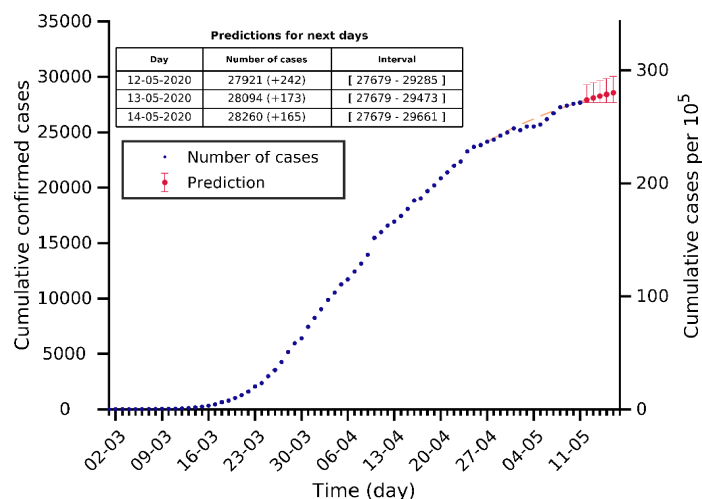
Netherlands 11-05-2020. Population: 17.1M. Current cumulated incidence: 250/10⁵



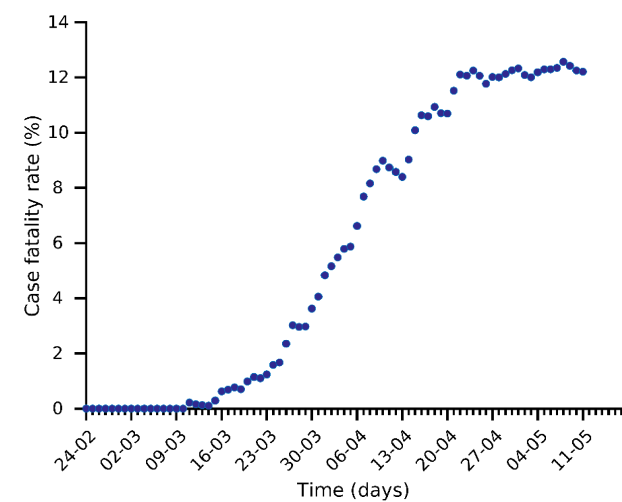
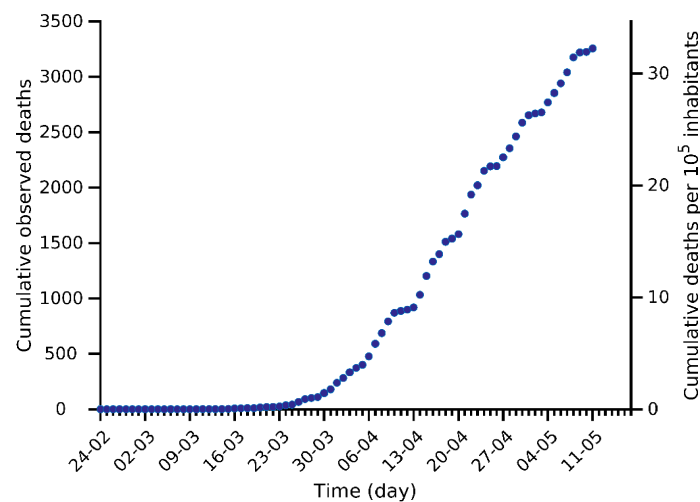
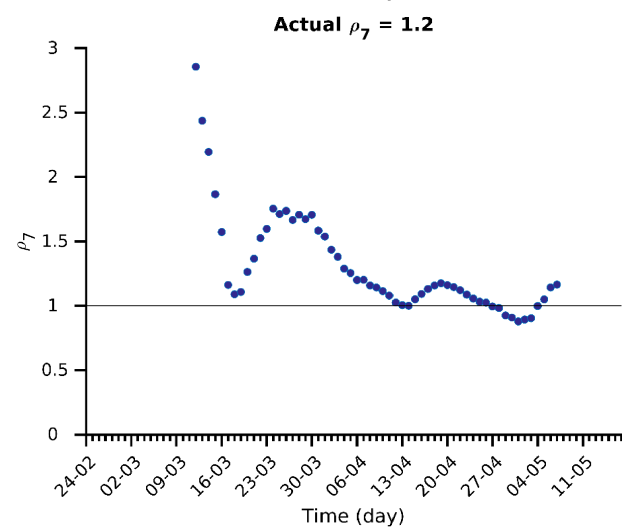
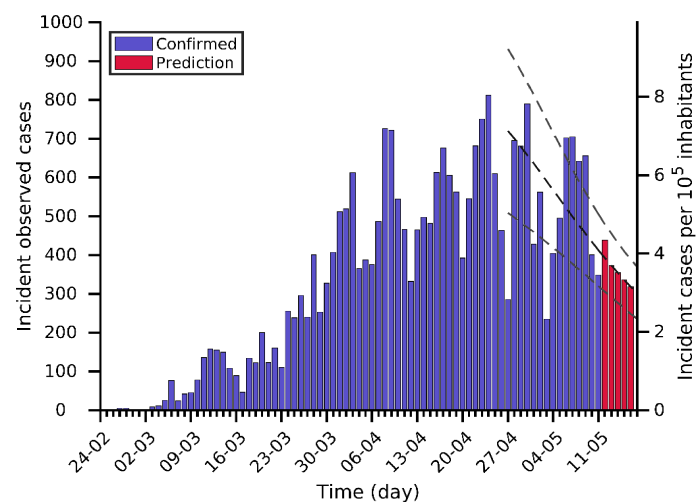
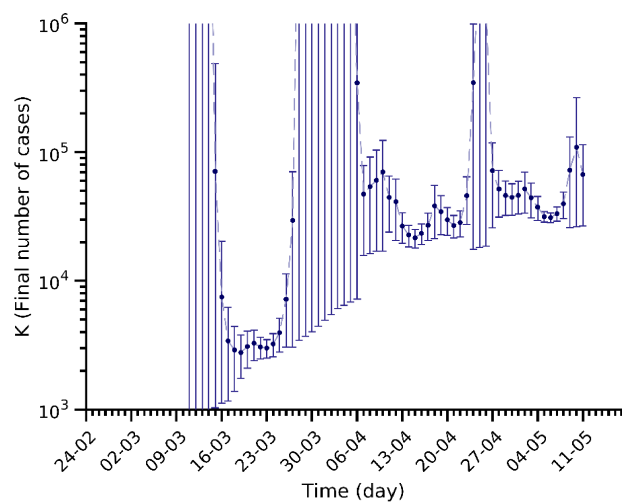
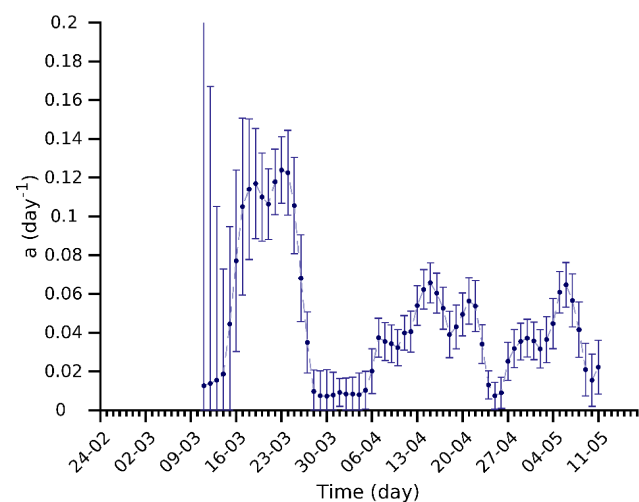
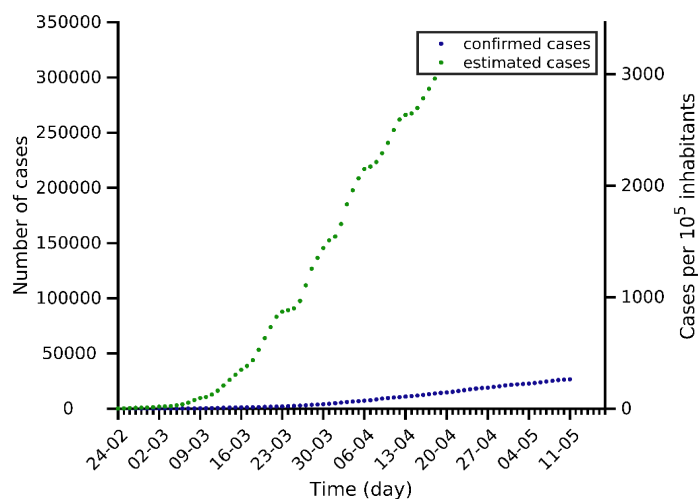
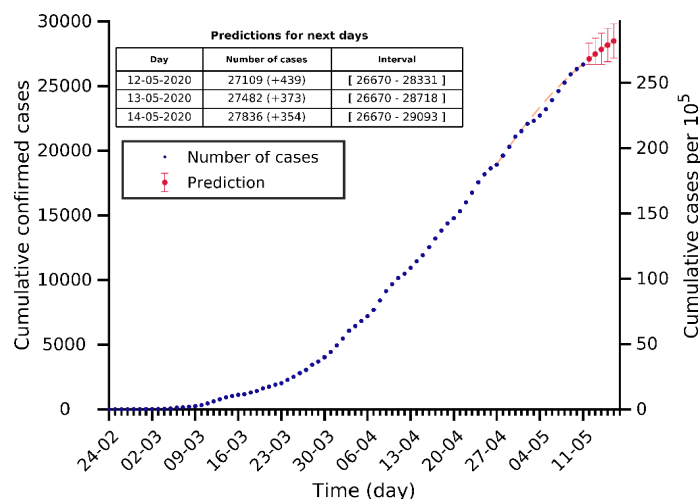
Switzerland 11-05-2020. Population: 8.7M. Current cumulated incidence: 350/10⁵



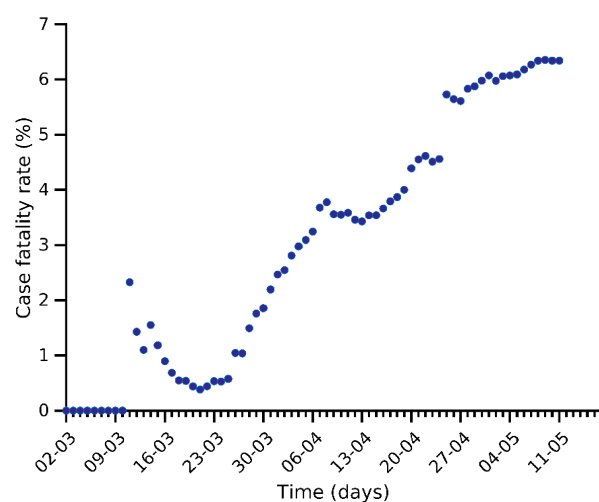
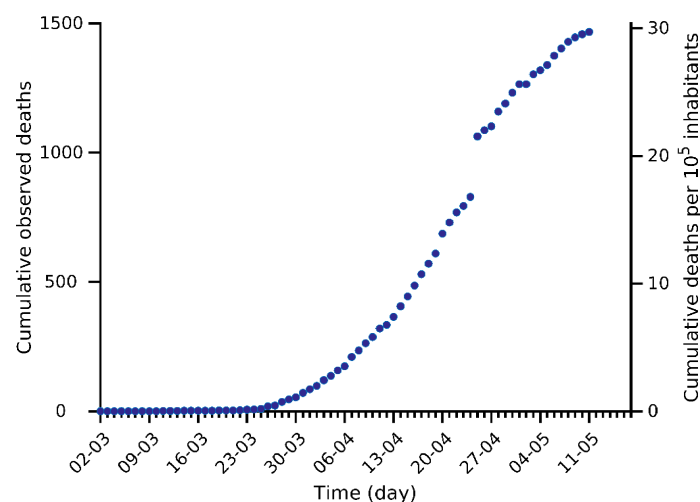
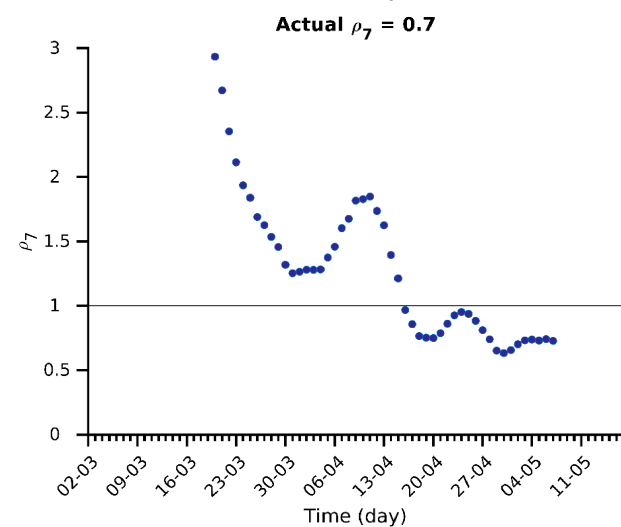
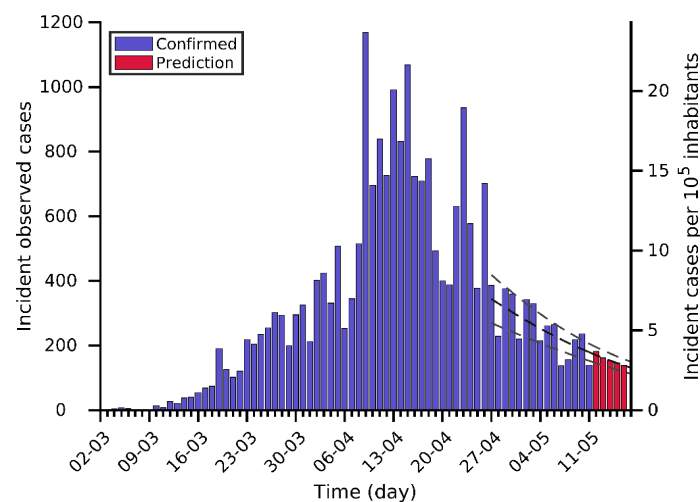
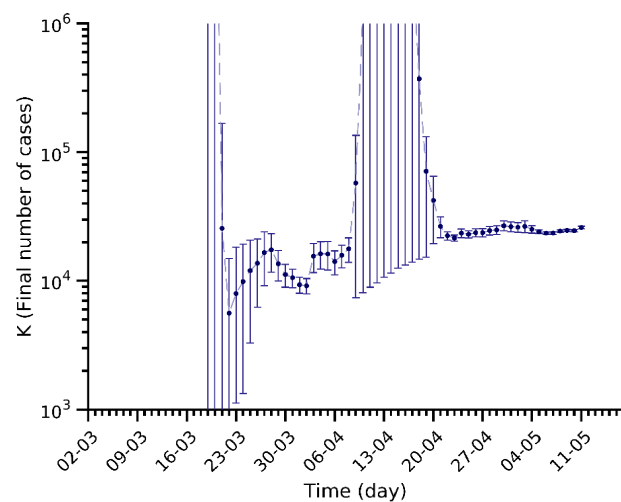
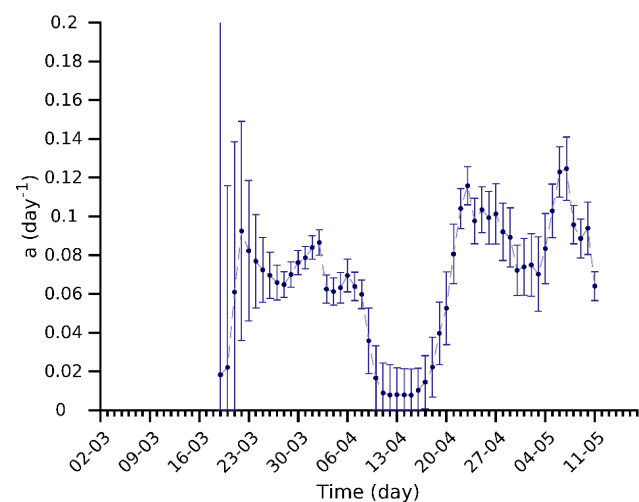
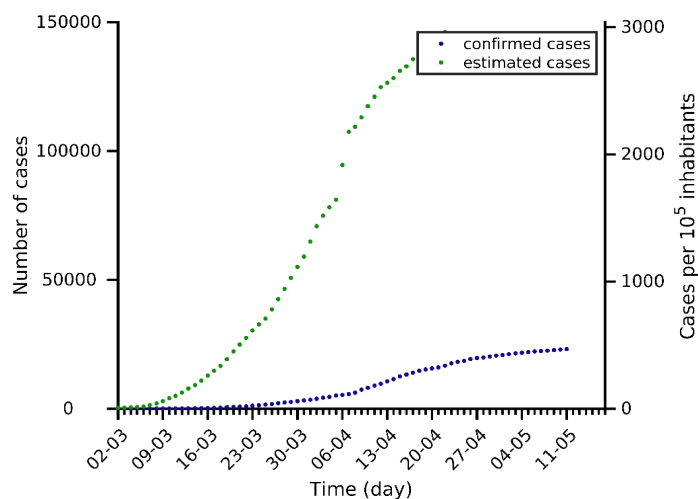
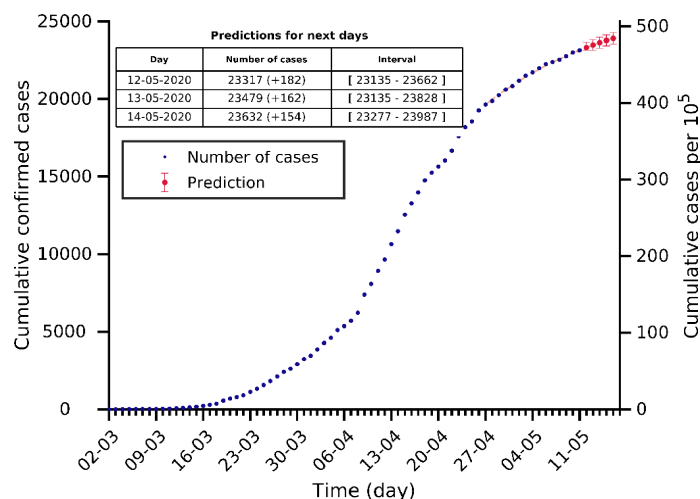
Portugal 11-05-2020. Population: 10.2M. Current cumulated incidence: 271/10⁵



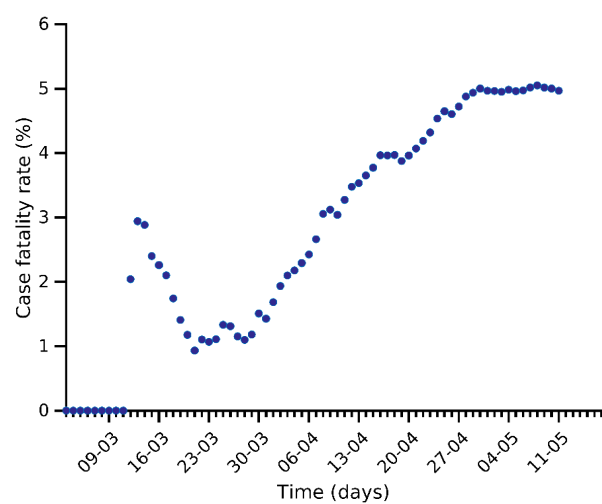
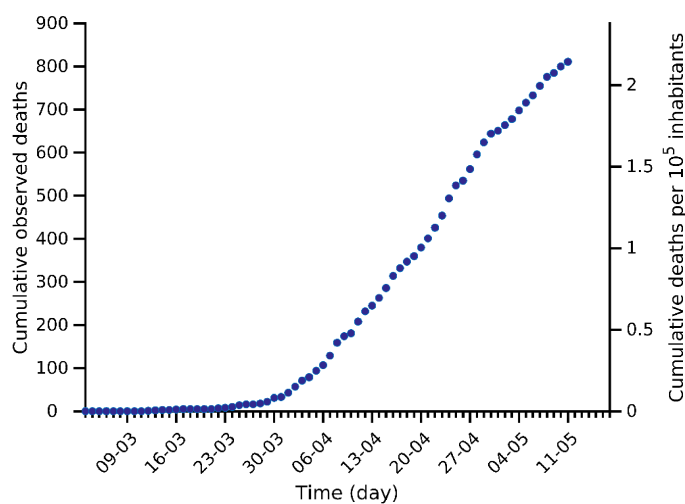
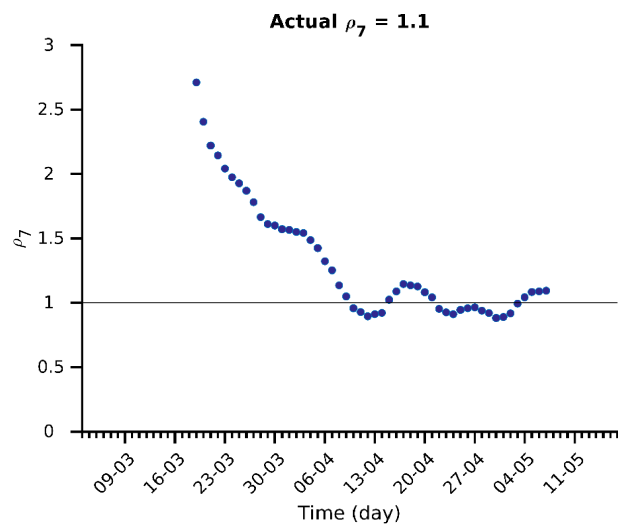
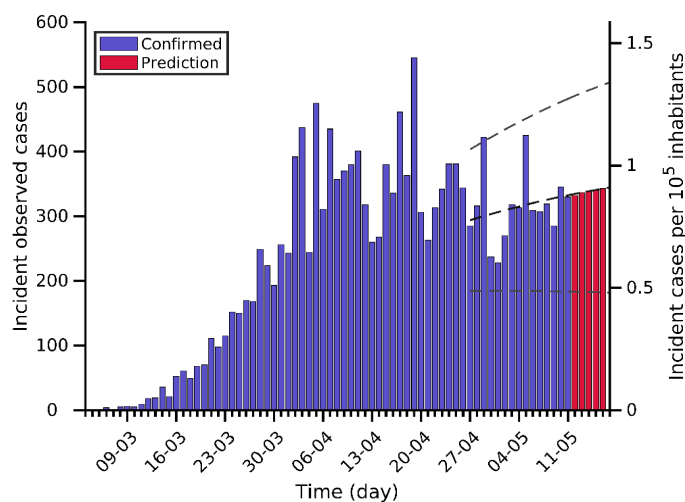
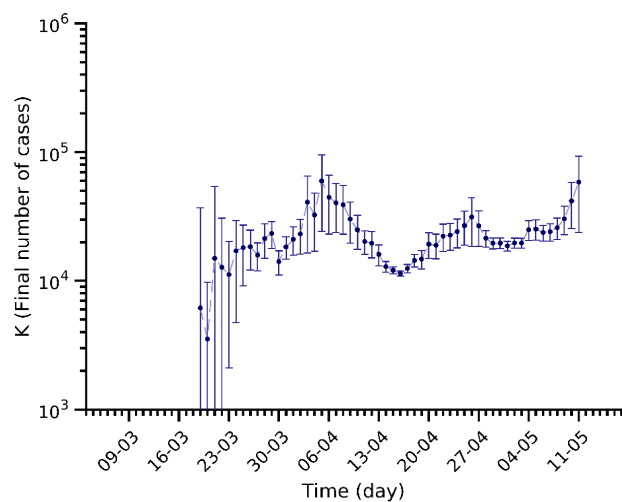
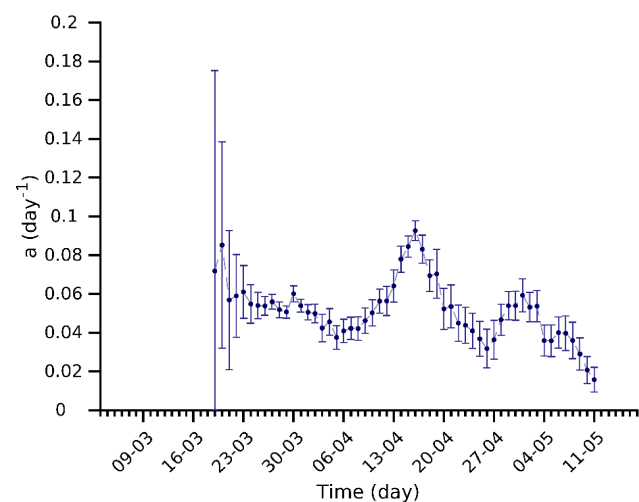
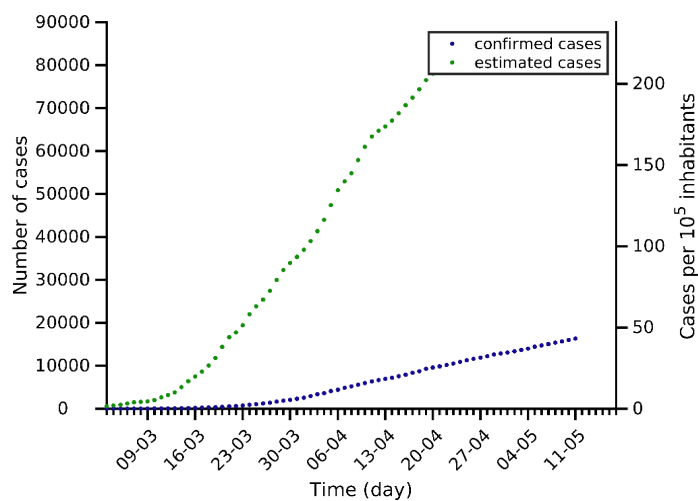
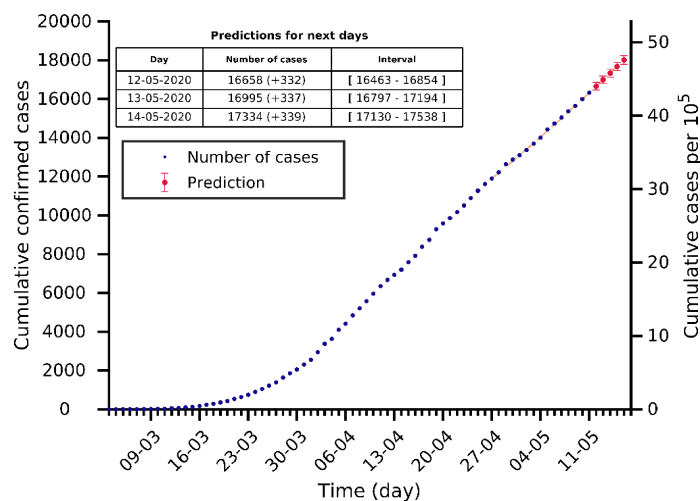
Sweden 11-05-2020. Population: 10.1M. Current cumulated incidence: 264/10⁵



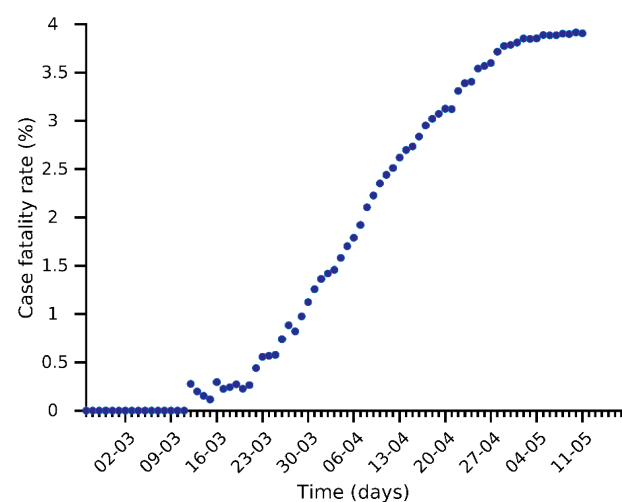
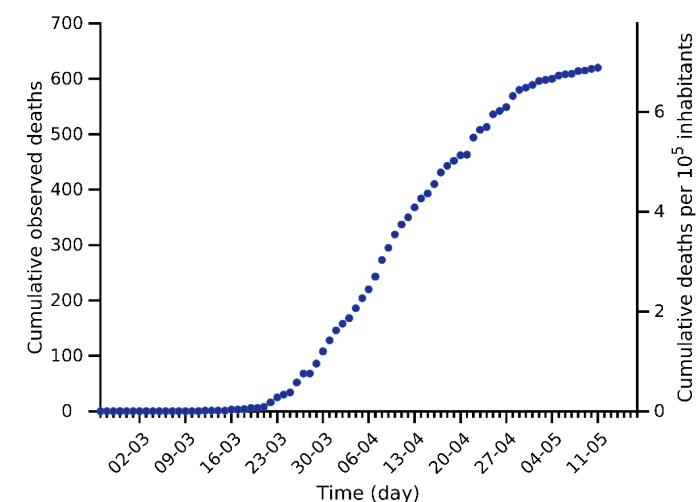
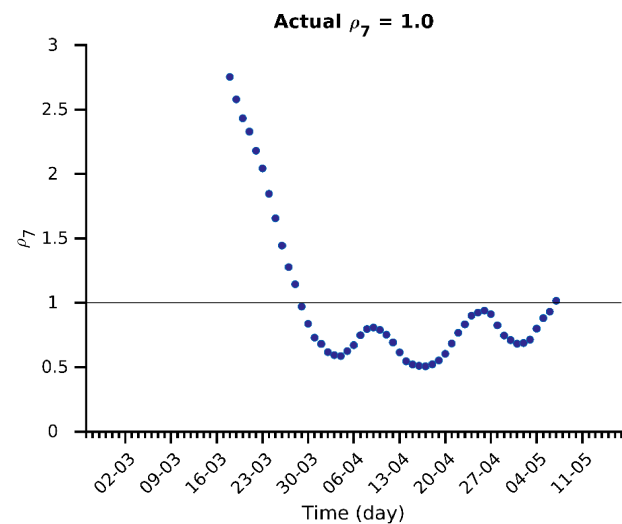
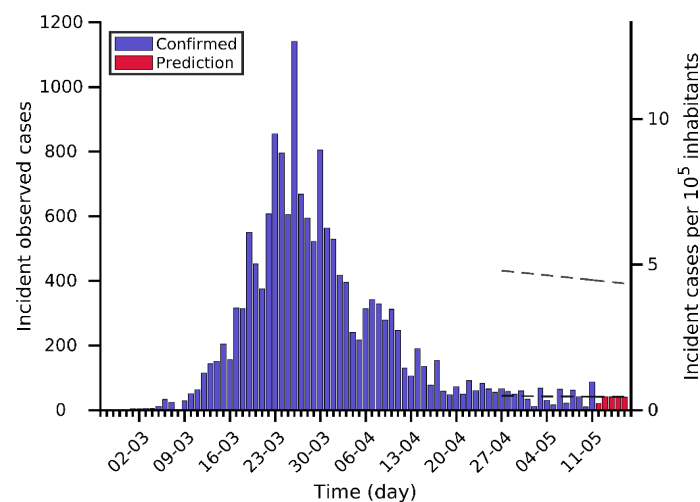
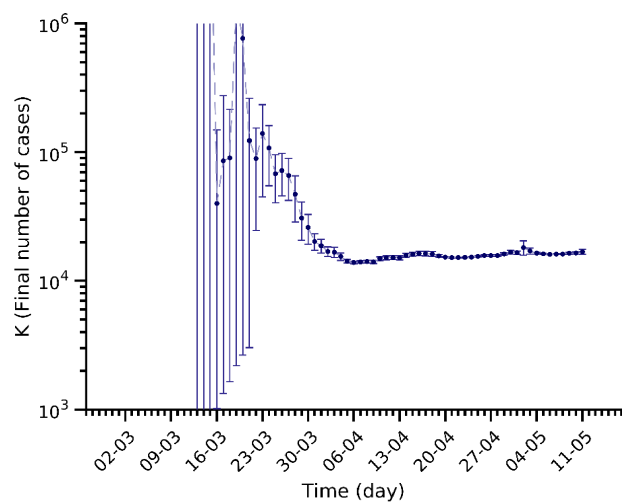
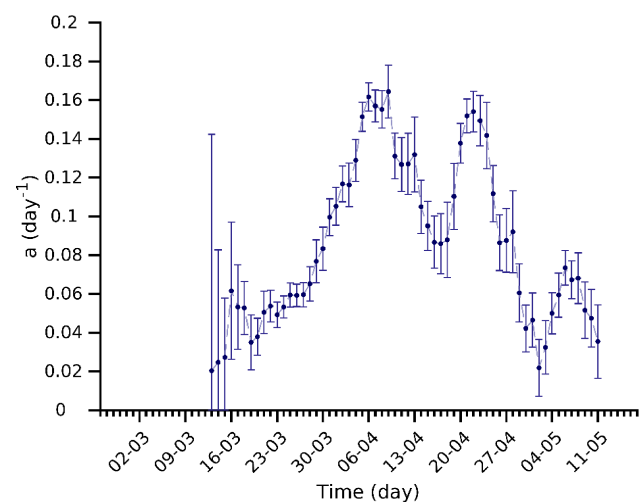
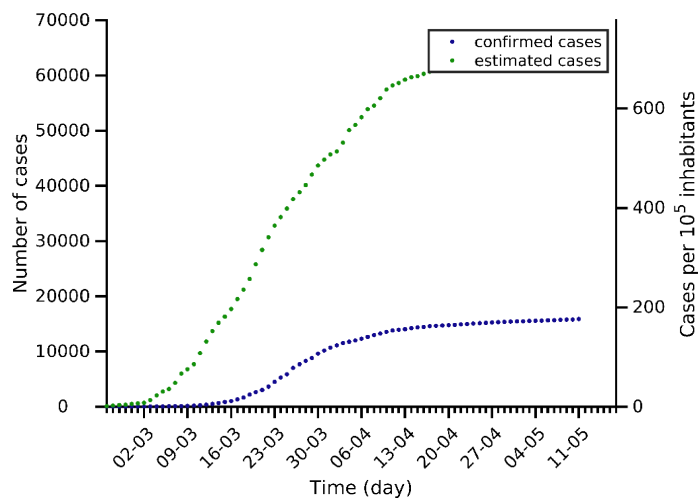
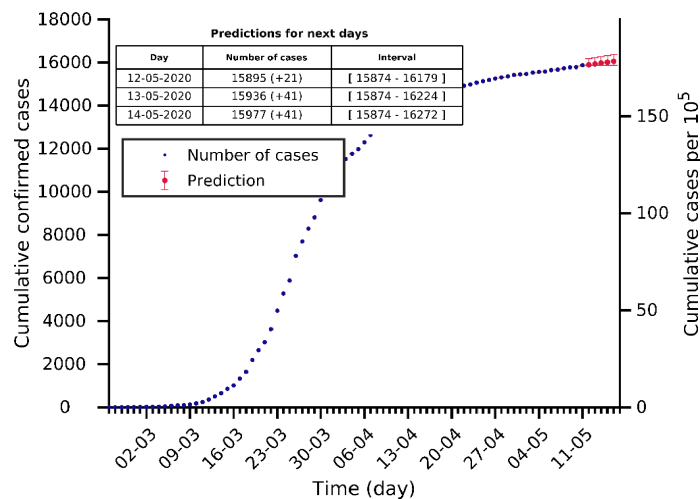
Ireland 11-05-2020. Population: 4.9M. Current cumulated incidence: 469/10⁵



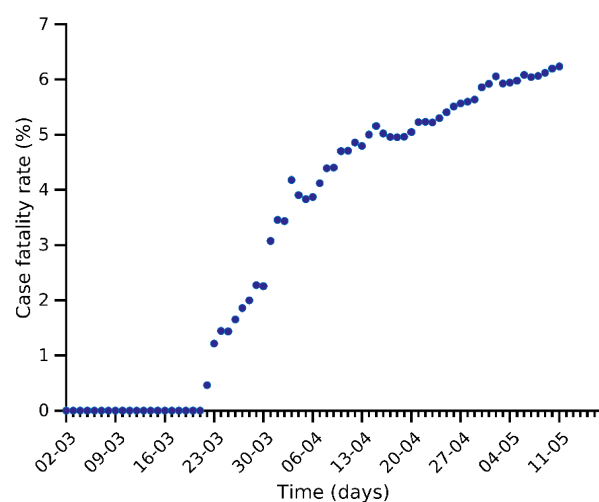
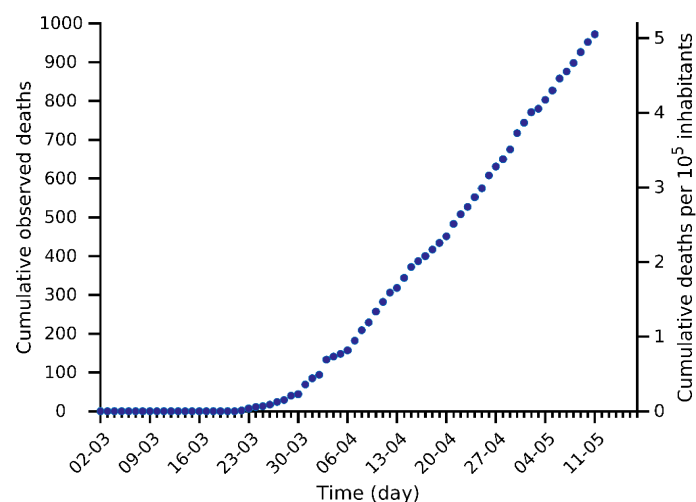
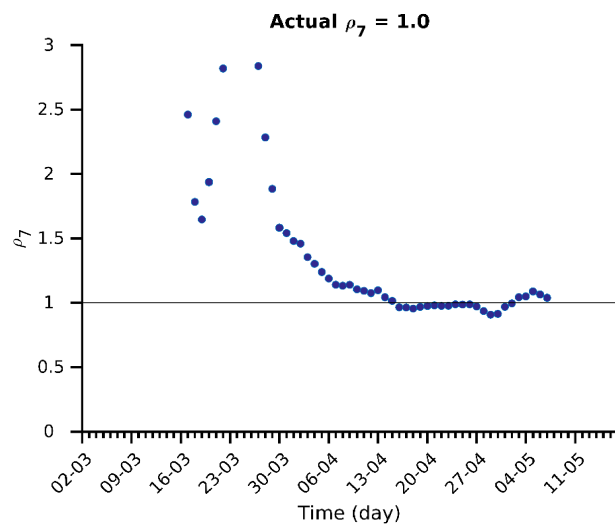
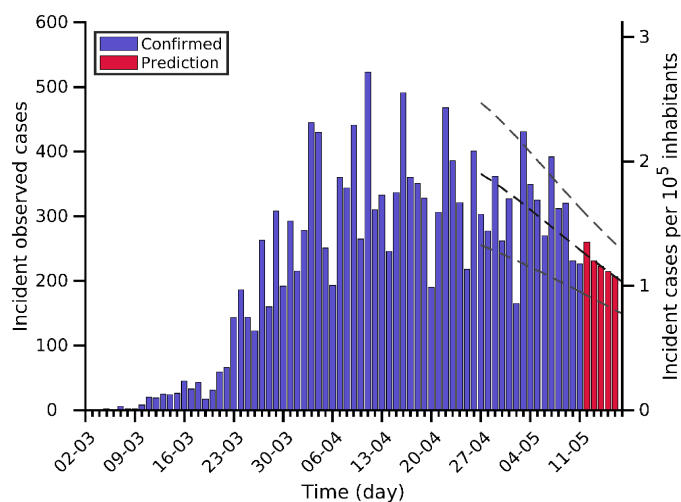
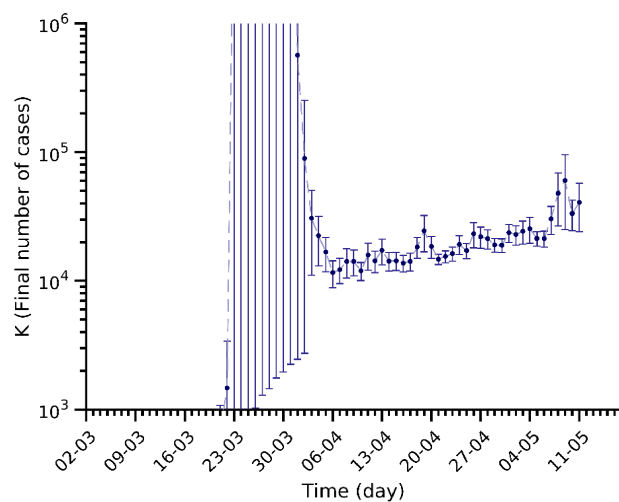
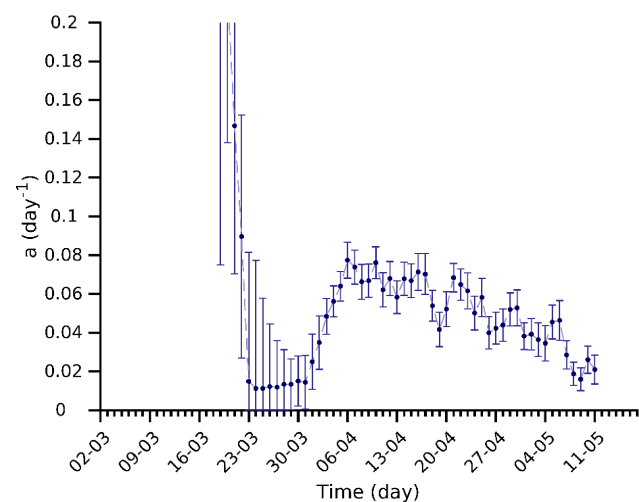
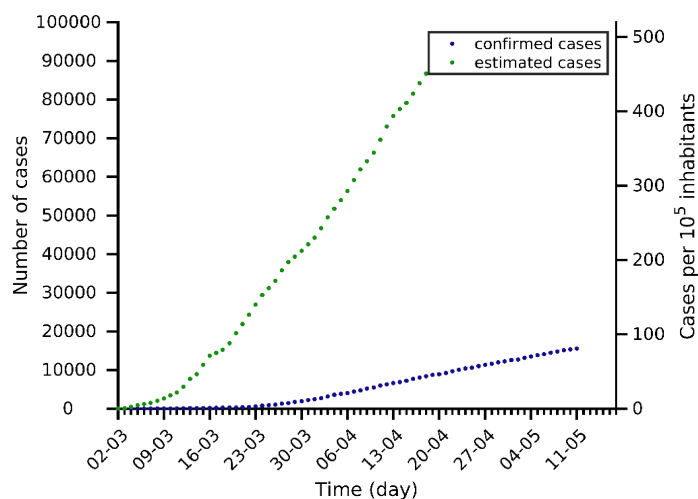
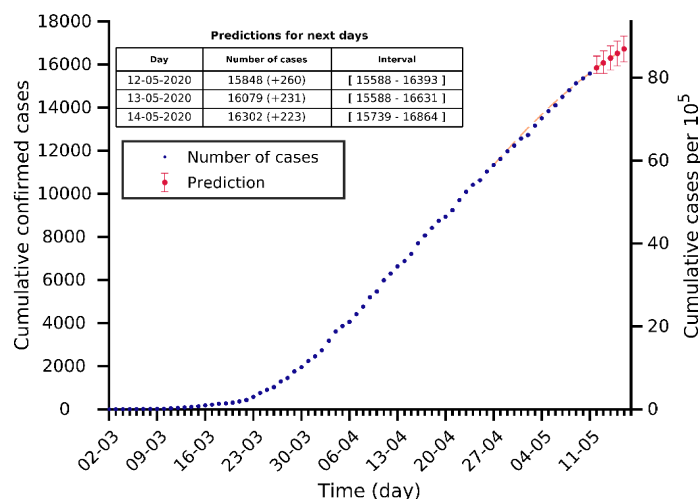
Poland 11-05-2020. Population: 37.8M. Current cumulated incidence: 43/10⁵



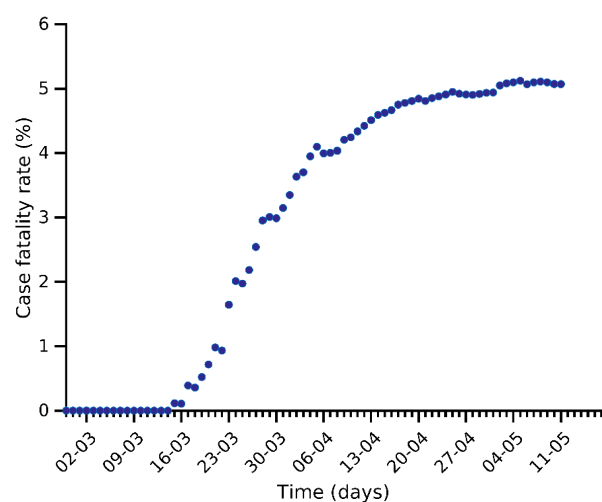
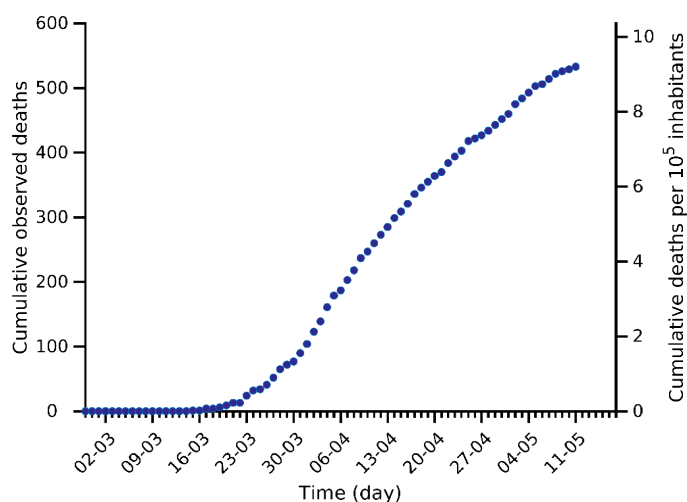
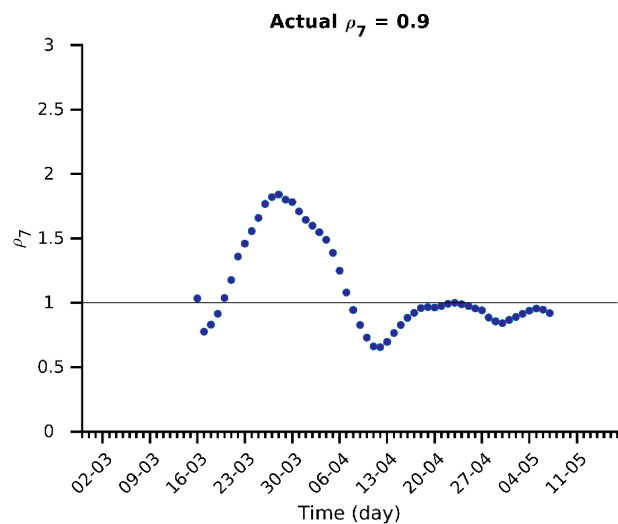
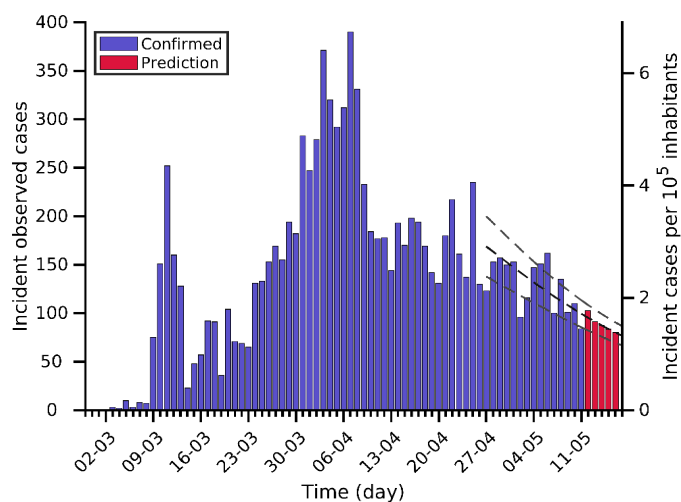
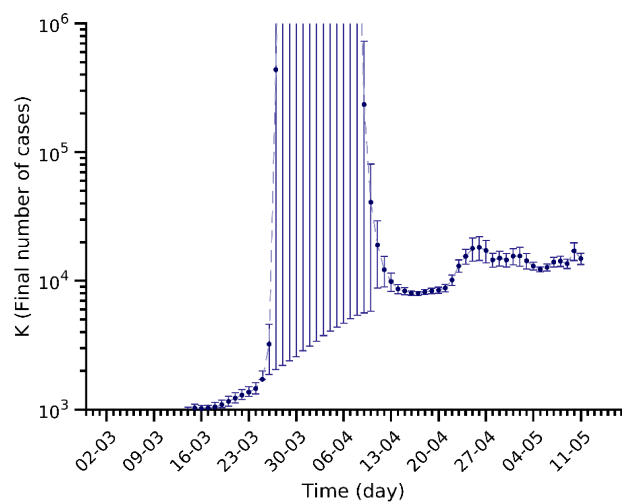
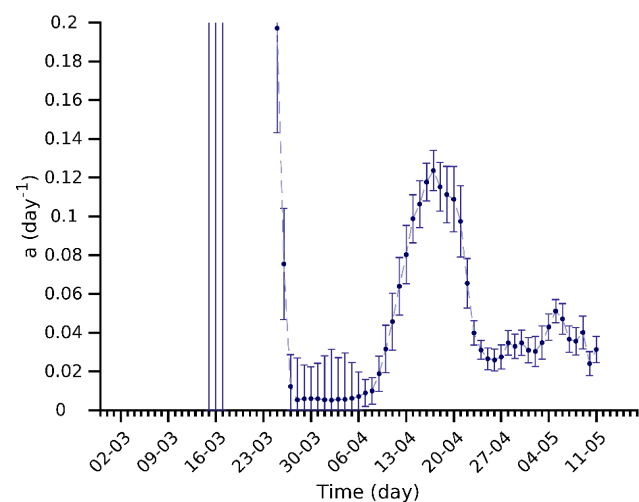
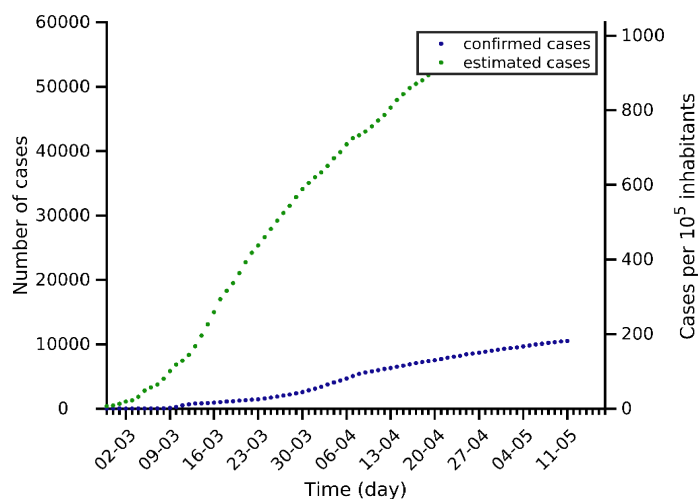
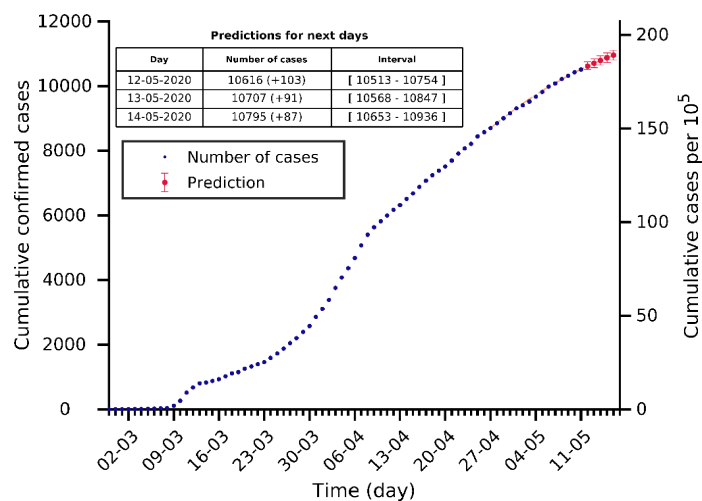
Austria 11-05-2020. Population: 9.0M. Current cumulated incidence: 176/10⁵



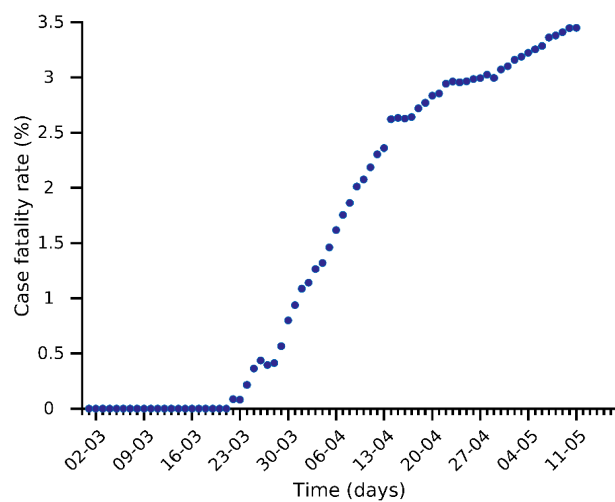
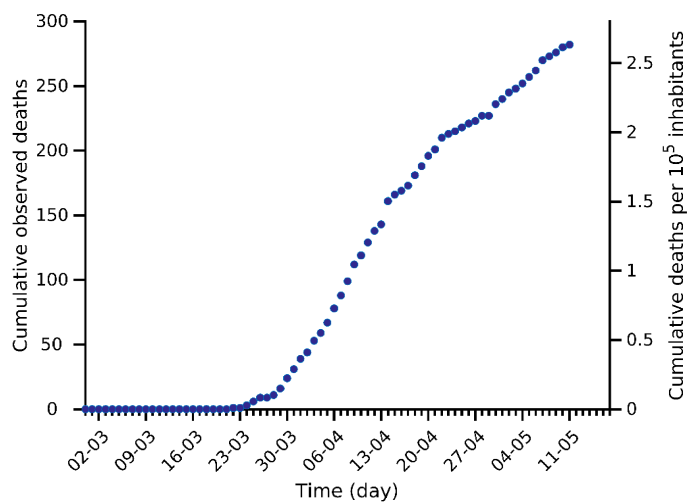
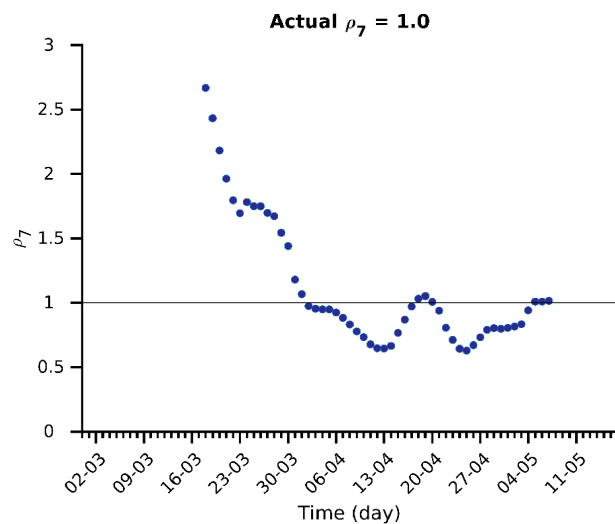
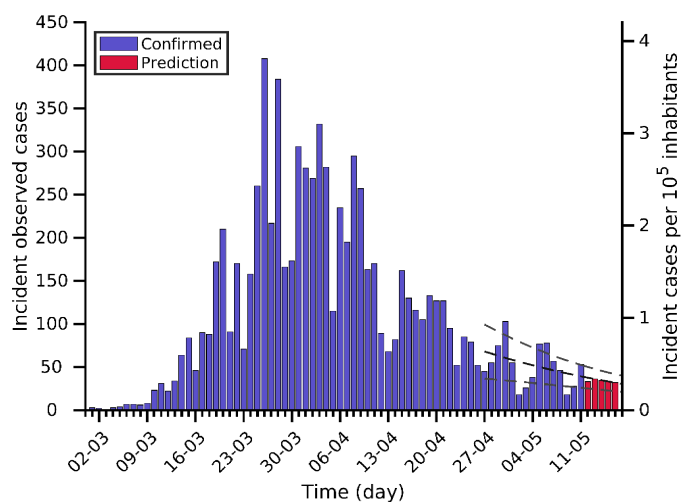
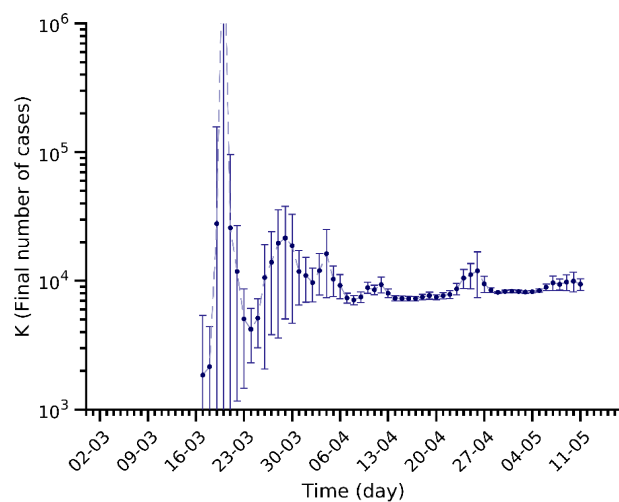
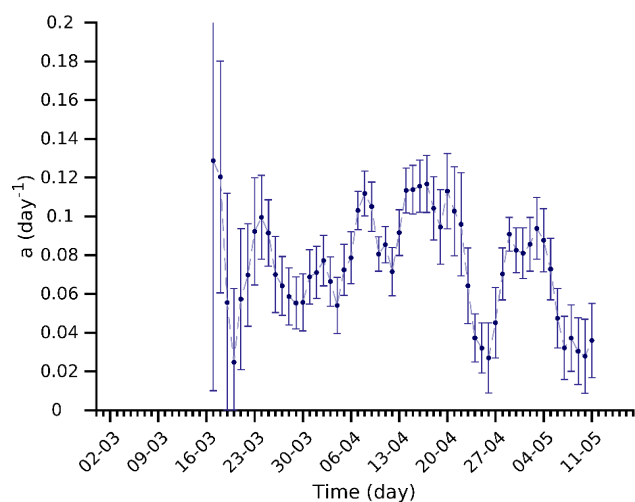
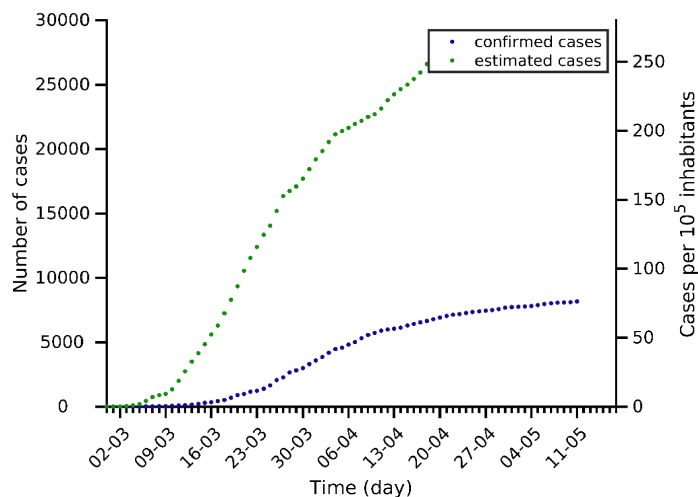
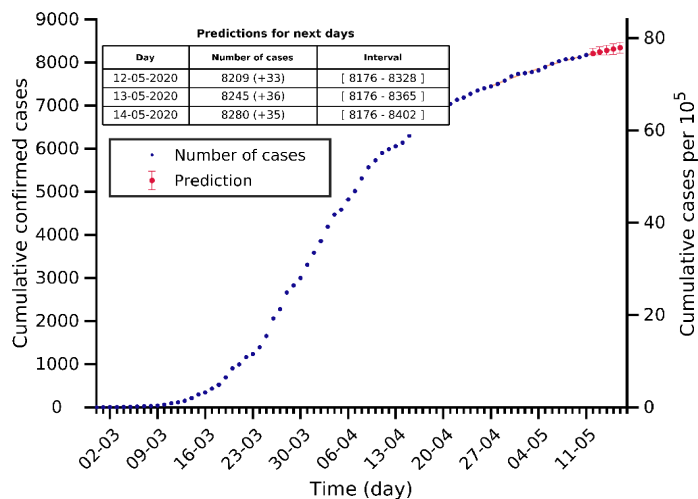
Romania 11-05-2020. Population: 19.2M. Current cumulated incidence: 81/10⁵



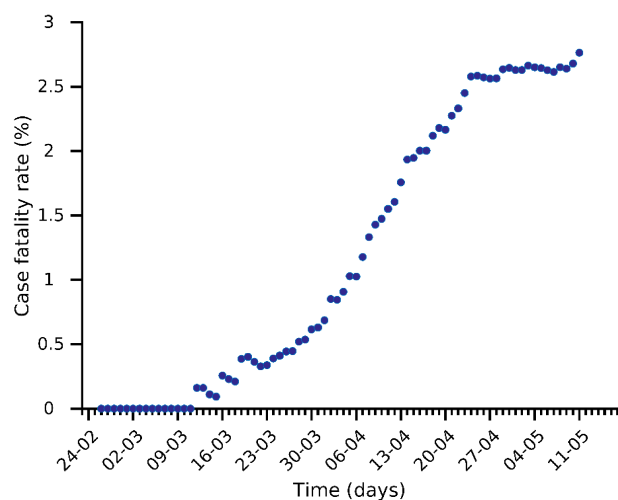
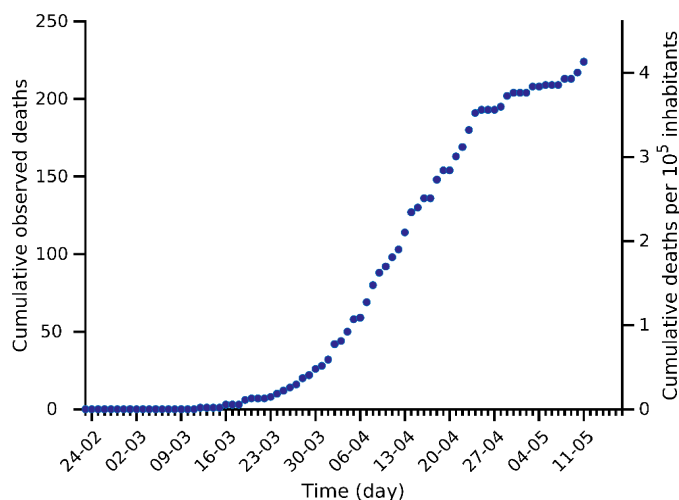
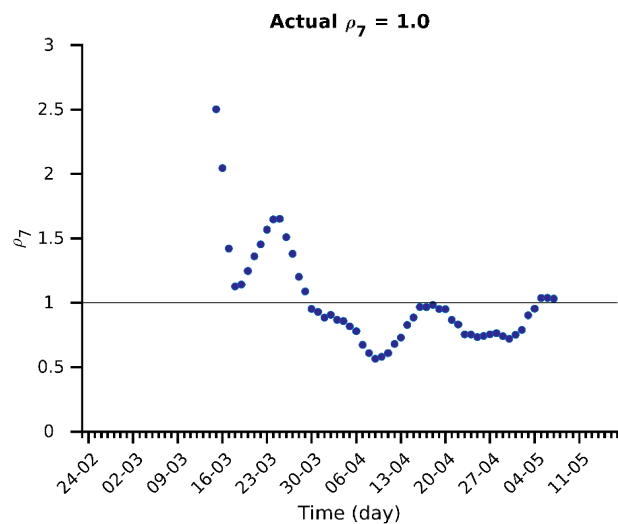
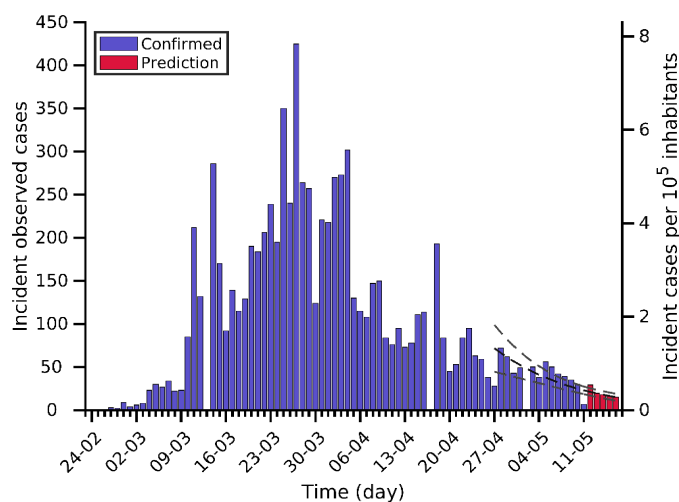
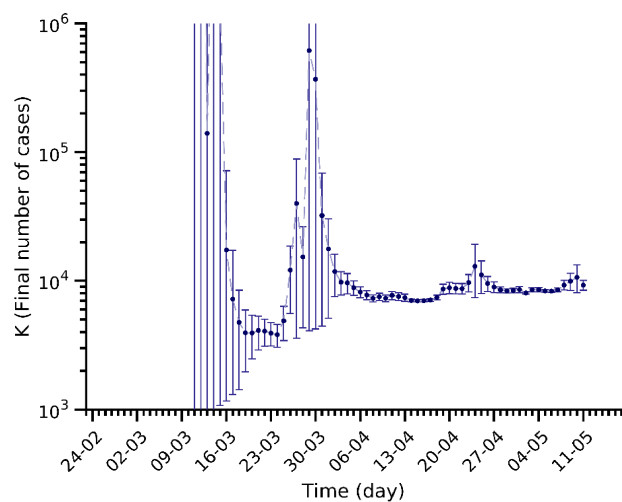
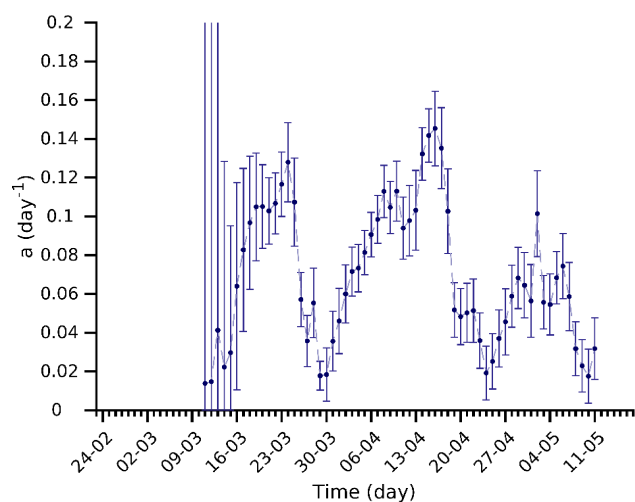
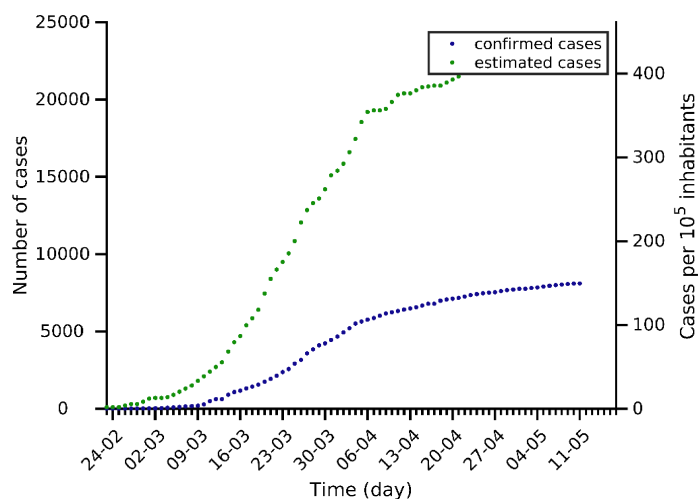
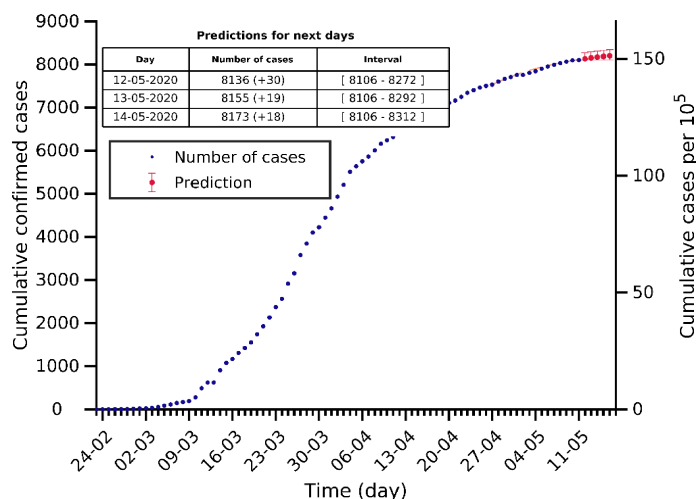
Denmark 11-05-2020. Population: 5.8M. Current cumulated incidence: 182/10⁵



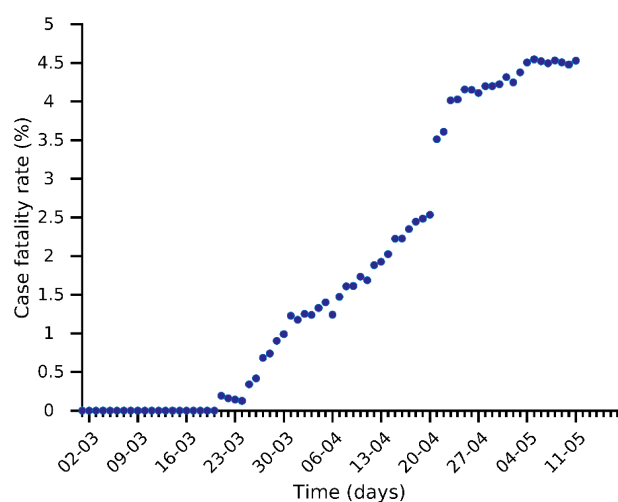
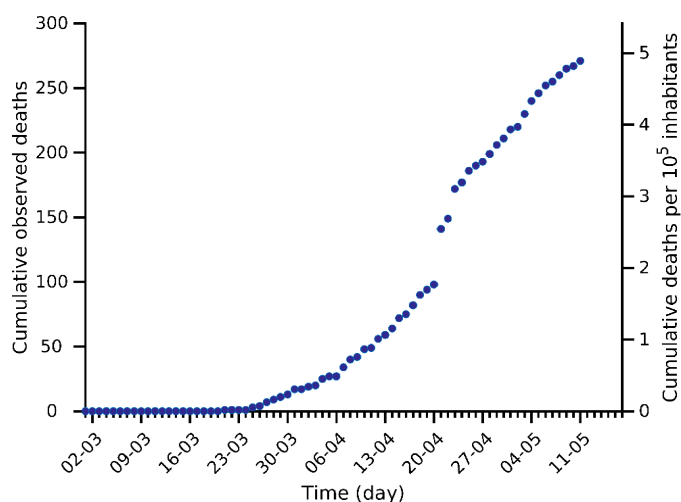
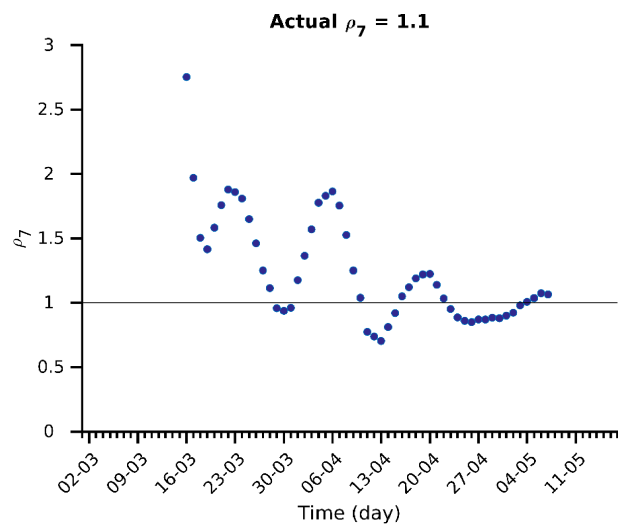
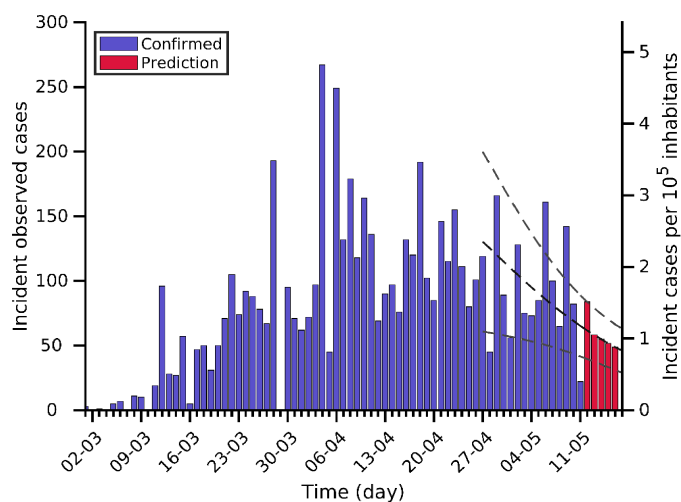
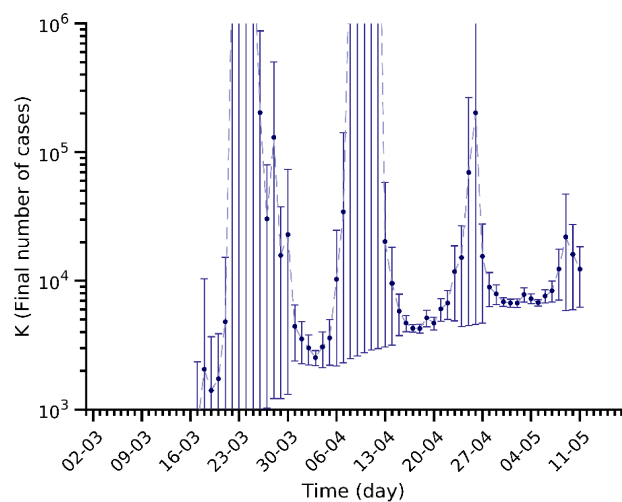
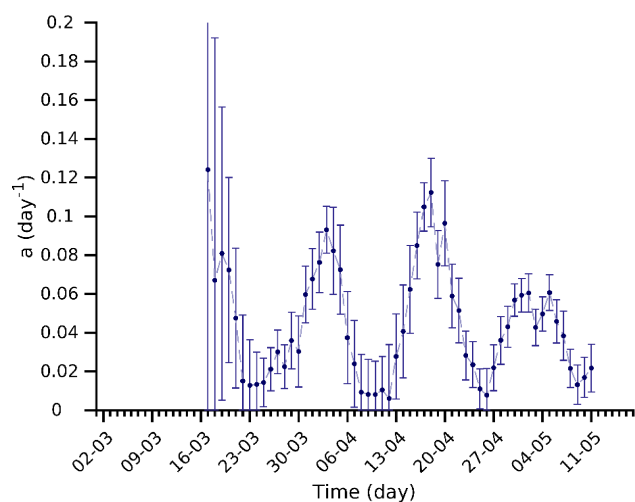
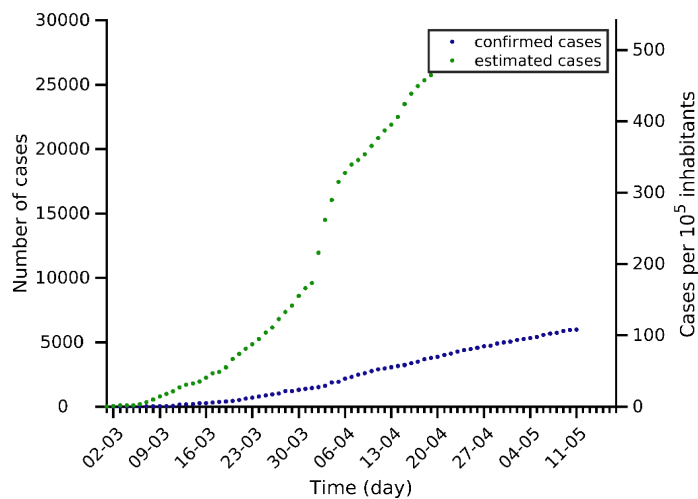
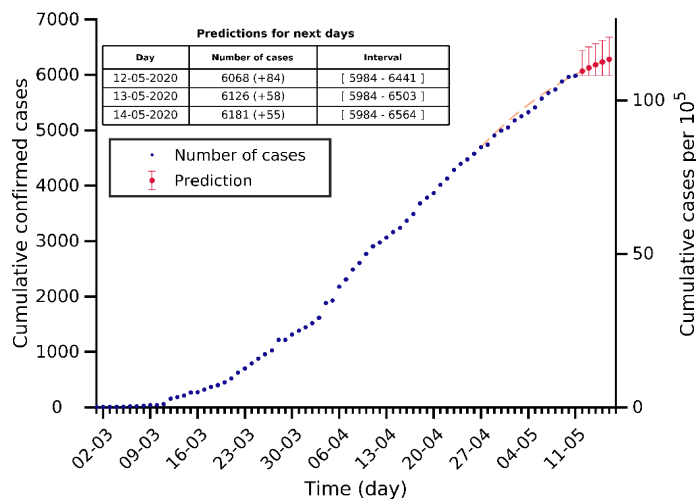
Czech Rep 11-05-2020. Population: 10.7M. Current cumulated incidence: 76/10⁵



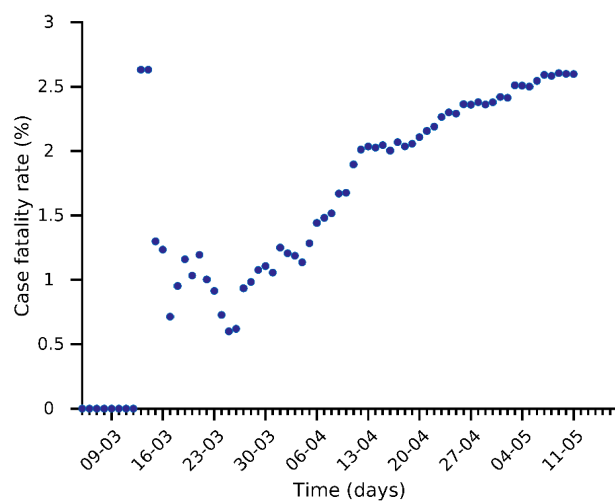
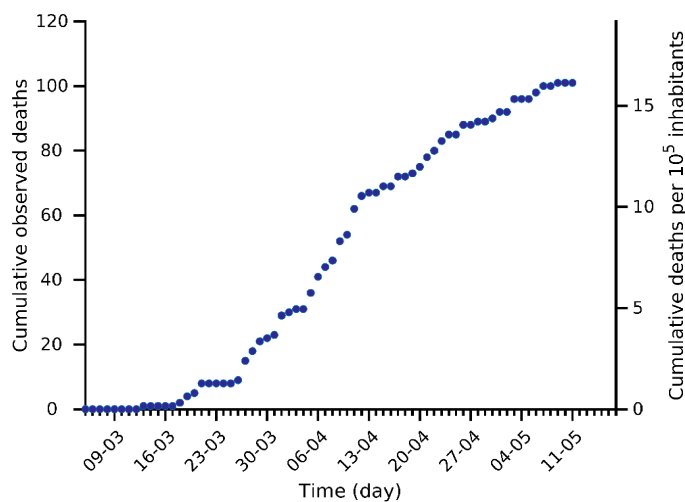
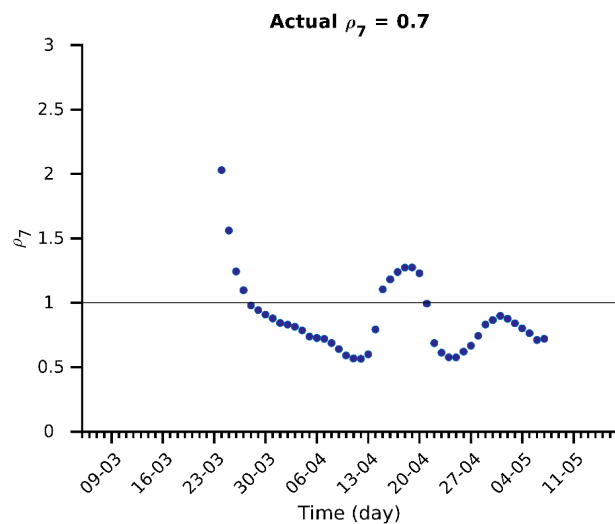
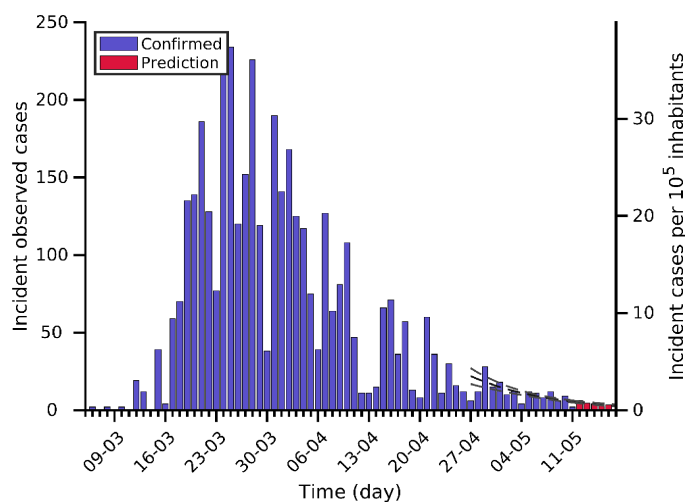
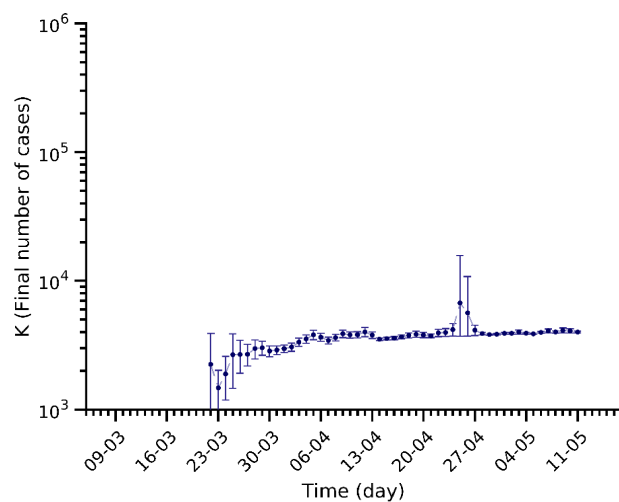
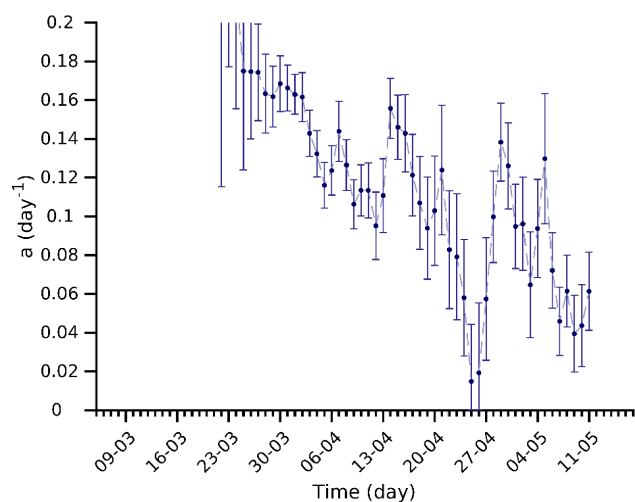
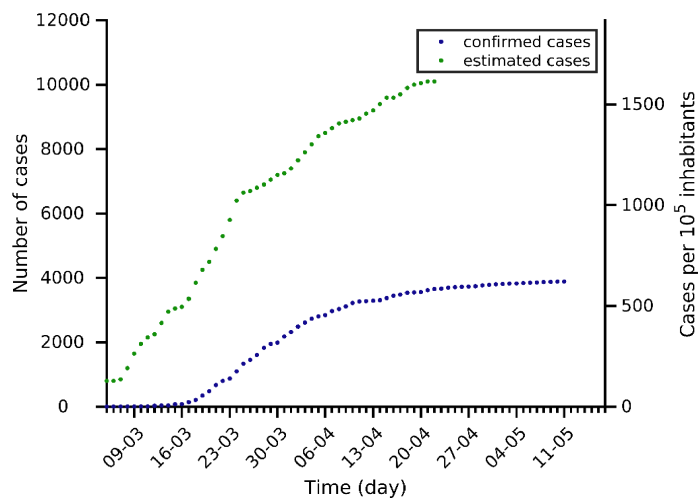
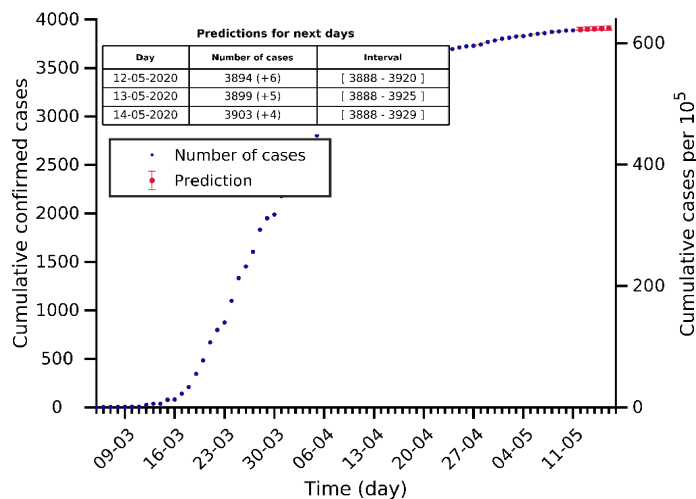
Norway 11-05-2020. Population: 5.4M. Current cumulated incidence: 150/10⁵



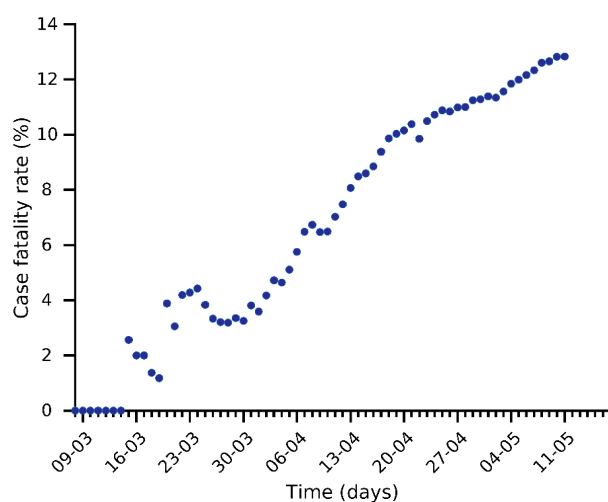
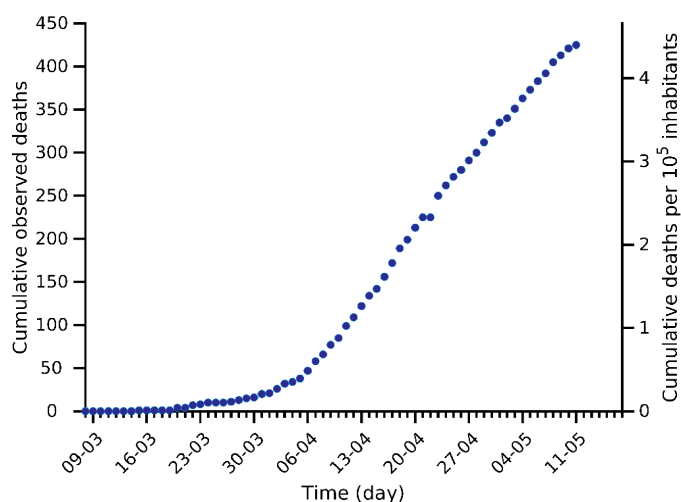
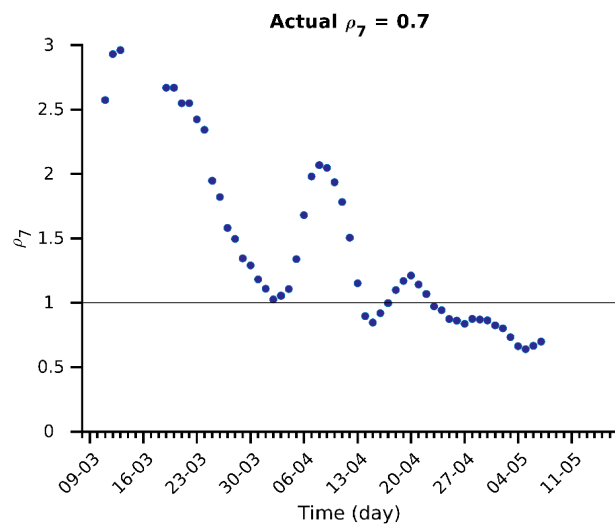
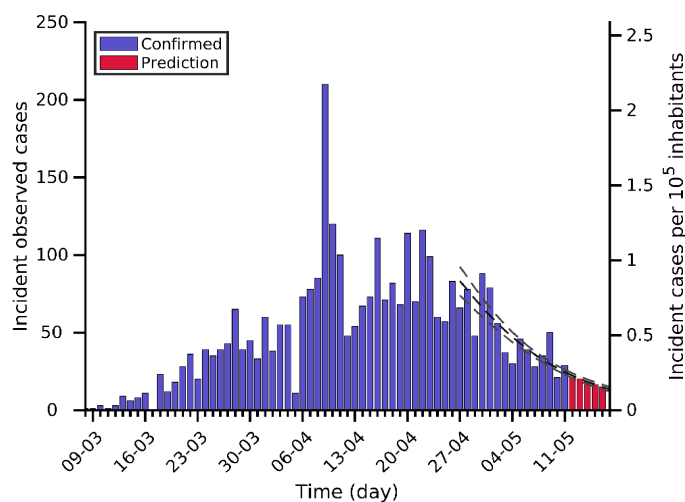
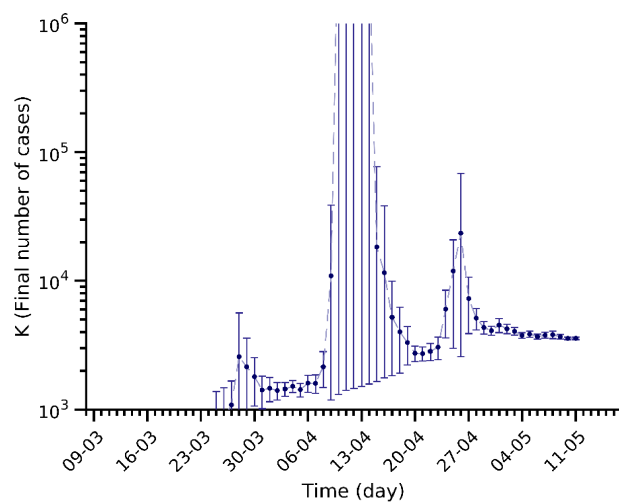
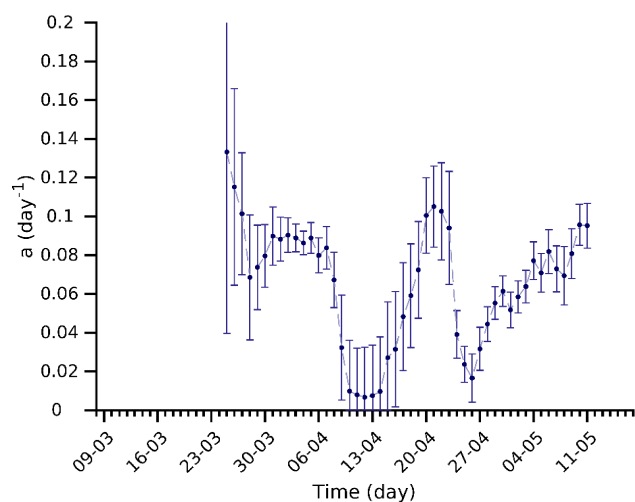
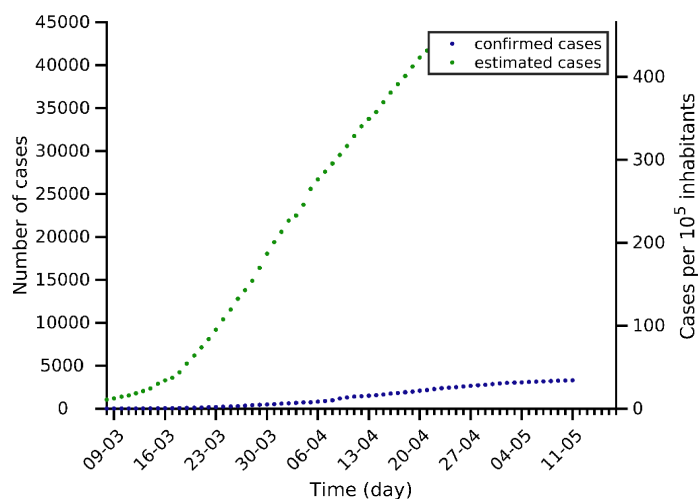
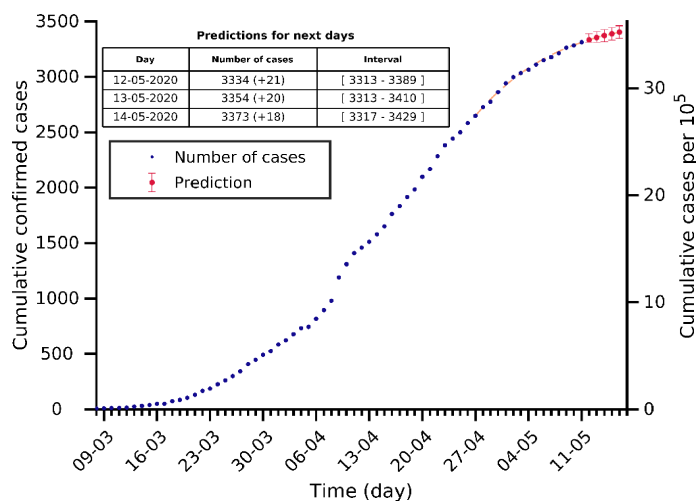
Finland 11-05-2020. Population: 5.5M. Current cumulated incidence: 108/10⁵



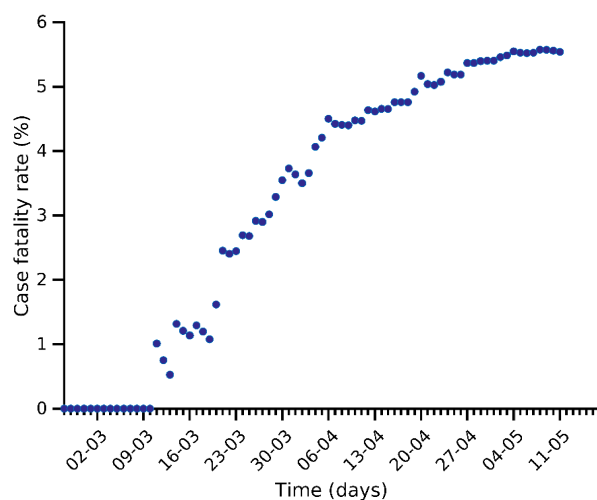
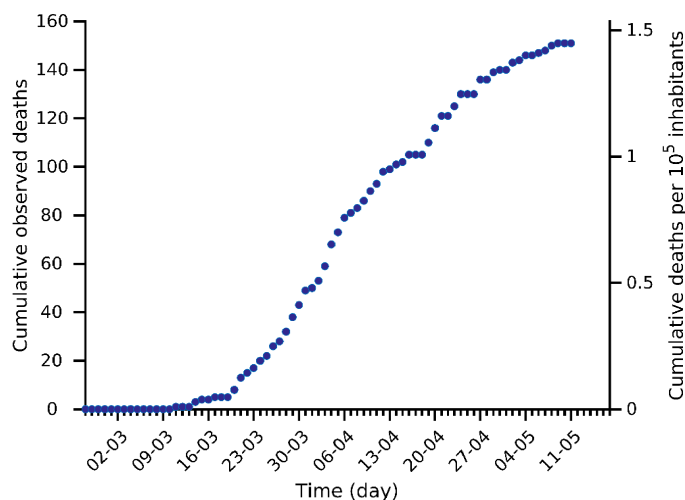
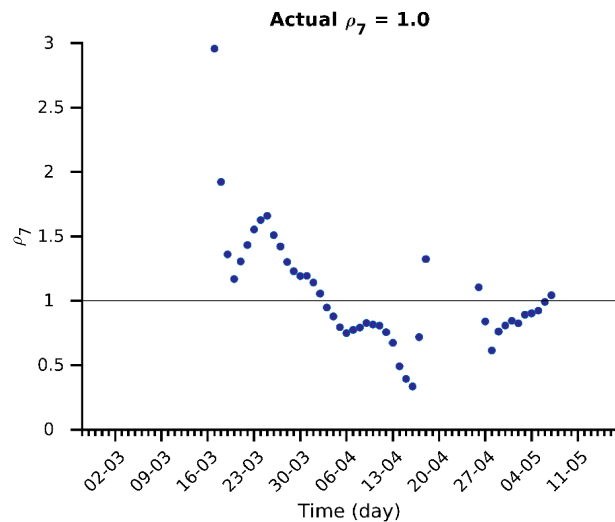
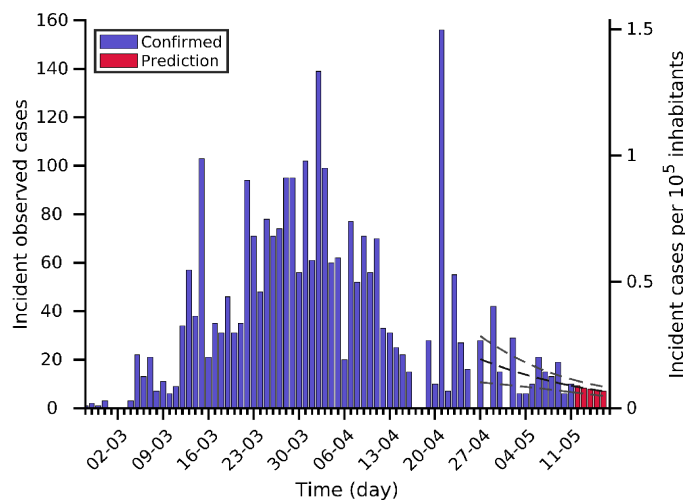
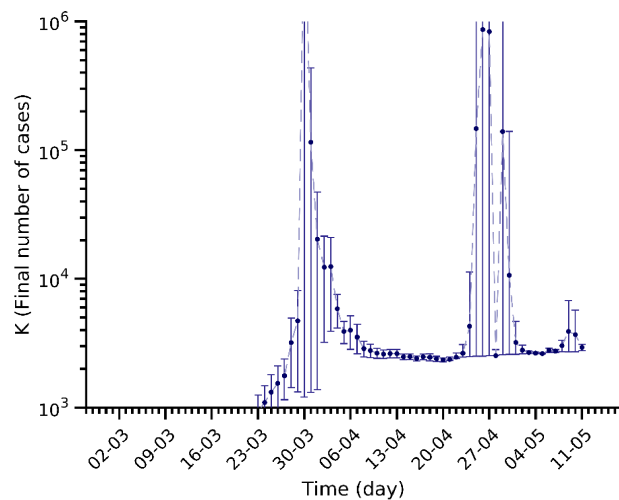
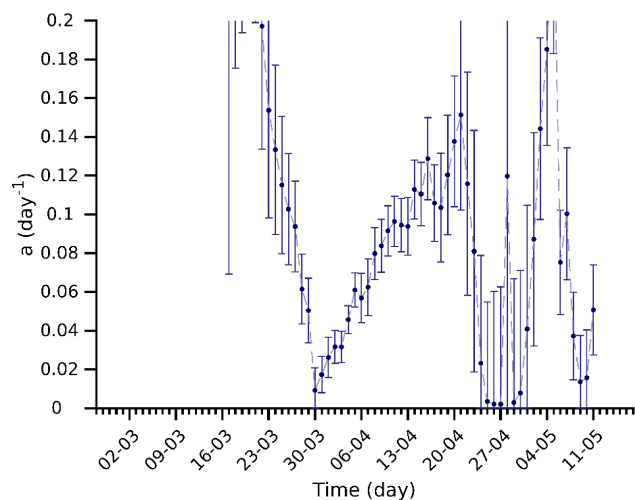
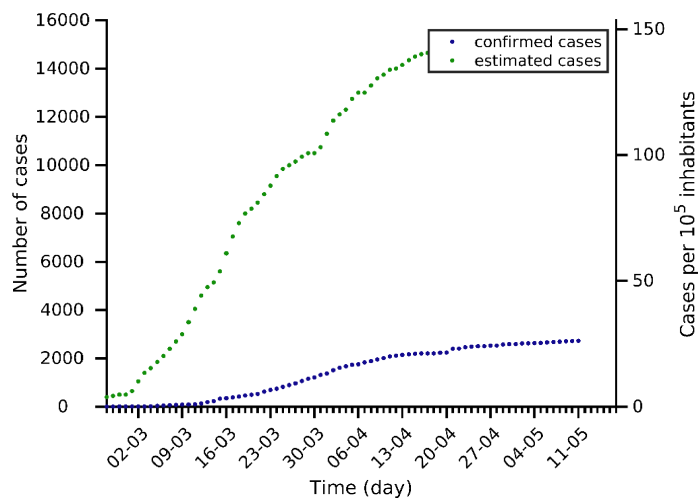
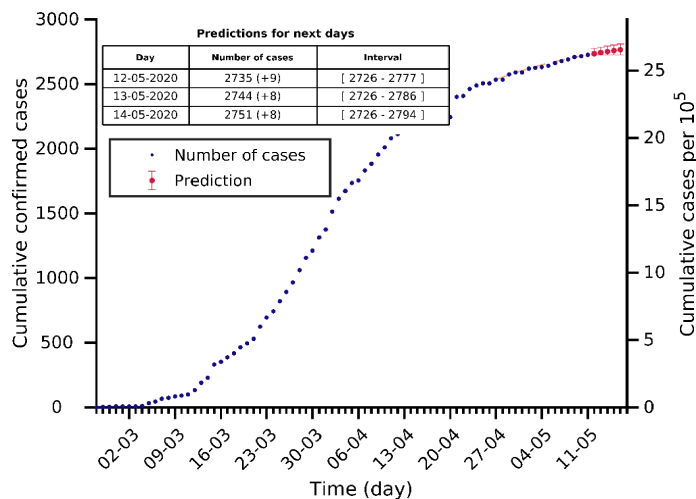
Luxembourg 11-05-2020. Population: 0.6M. Current cumulated incidence: 621/10⁵



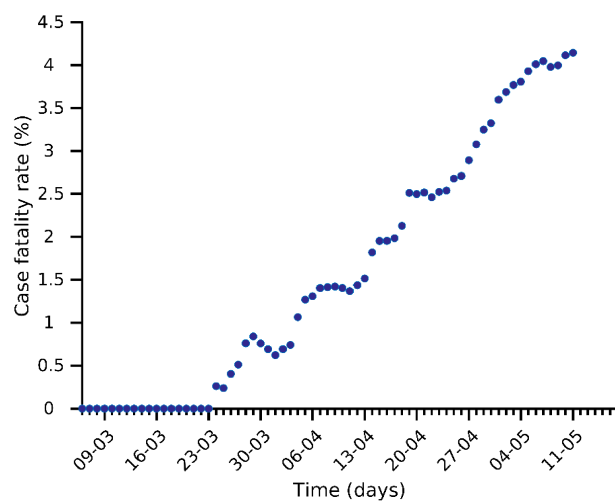
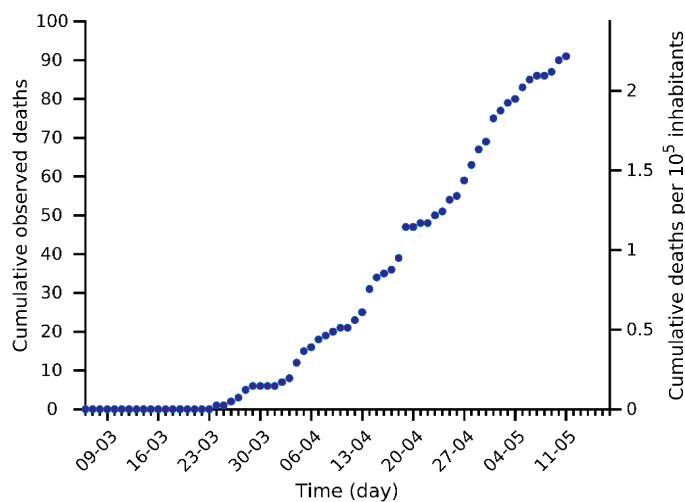
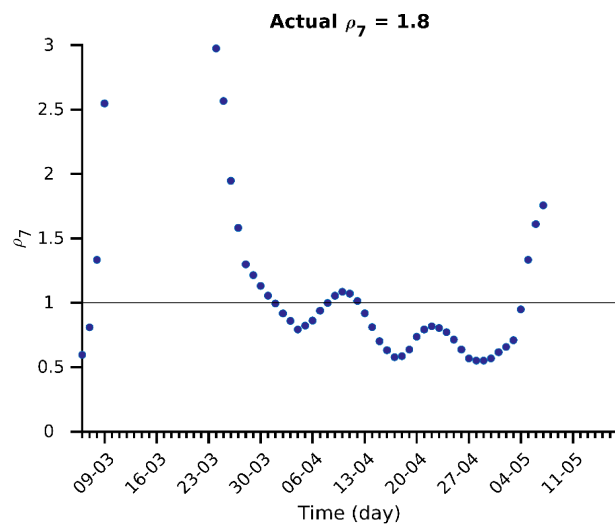
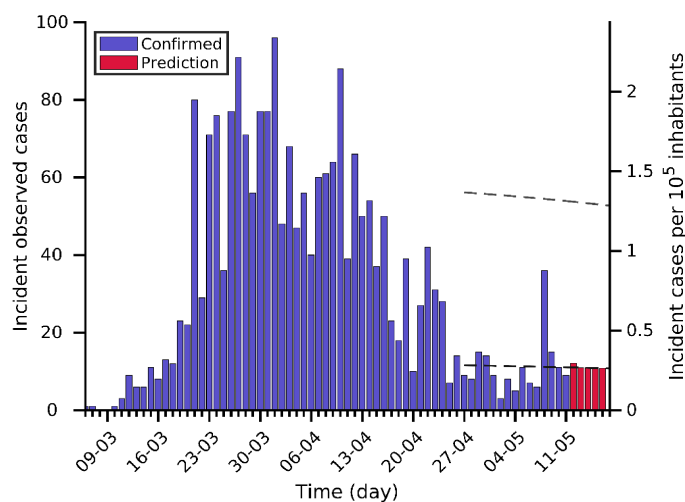
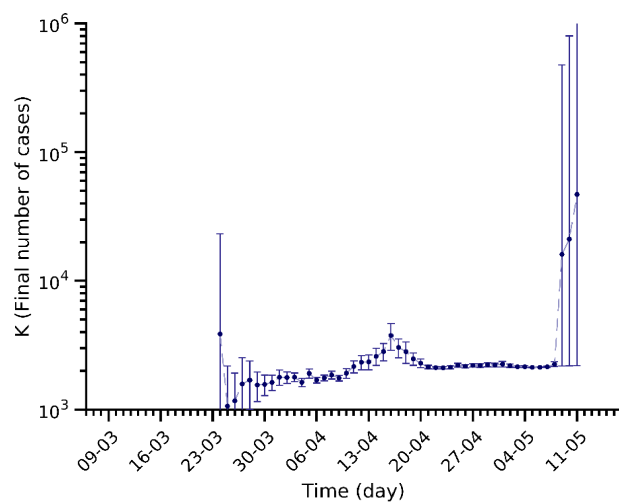
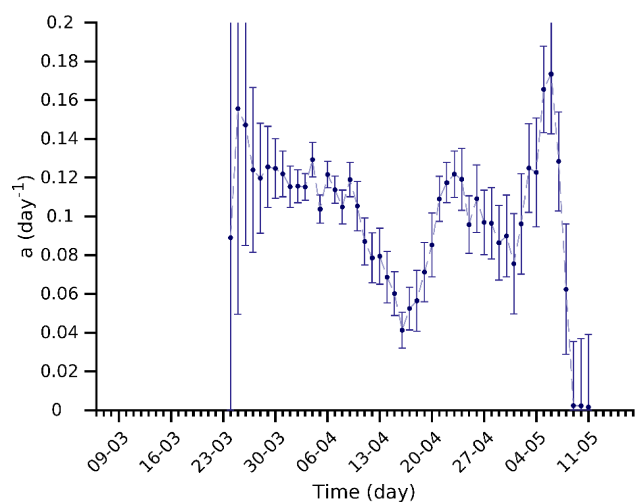
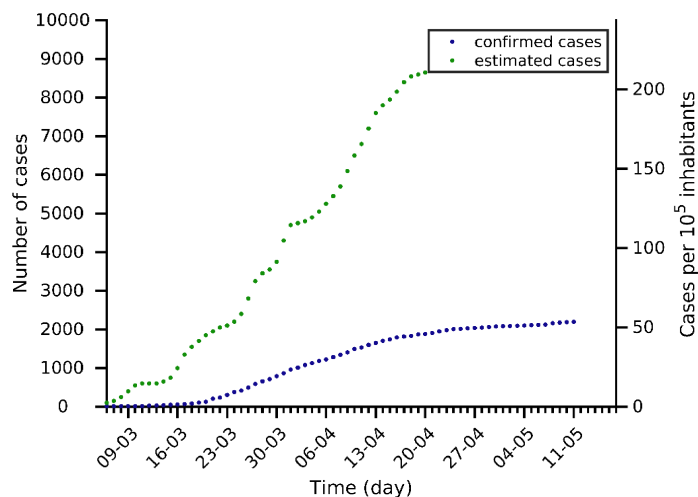
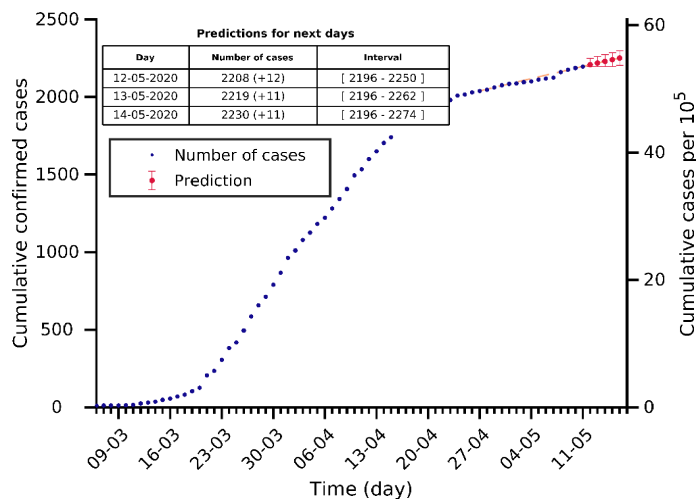
Hungary 11-05-2020. Population: 9.7M. Current cumulated incidence: 34/10⁵



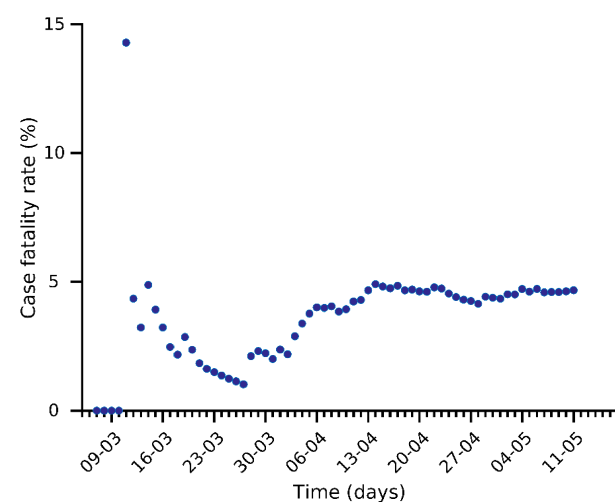
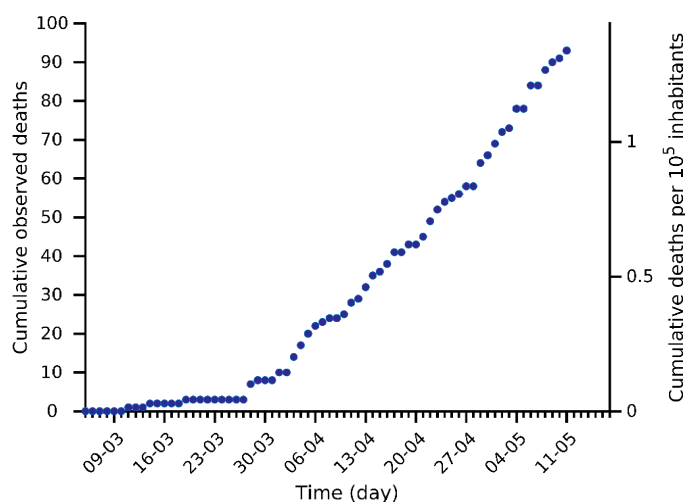
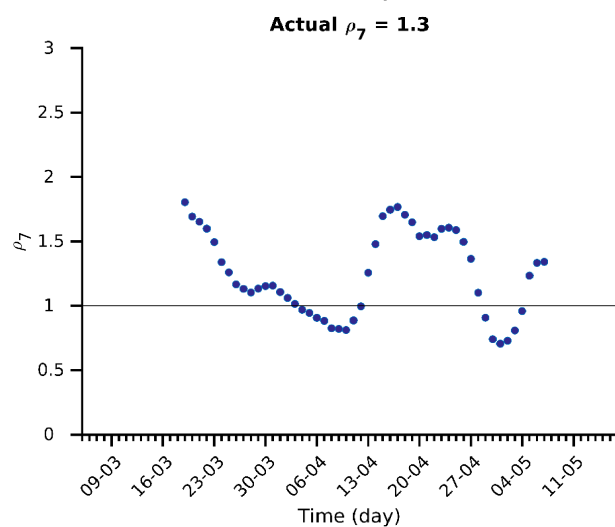
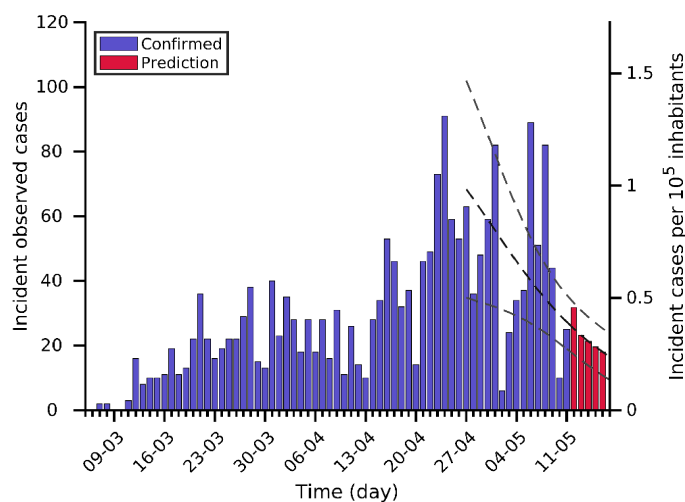
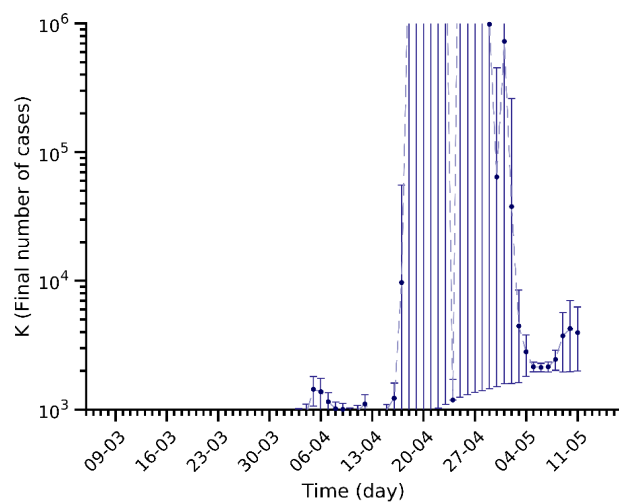
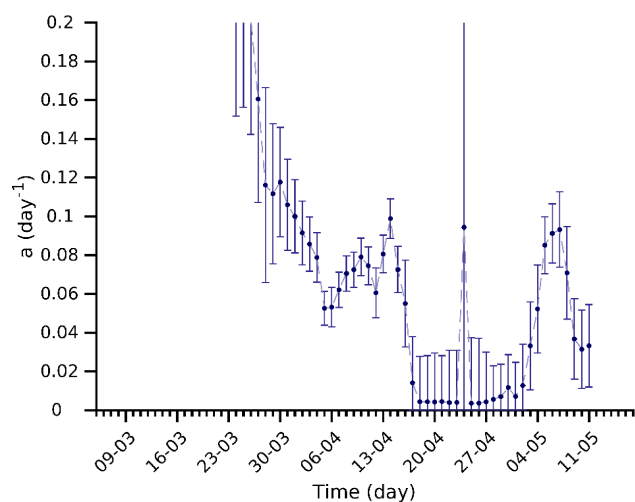
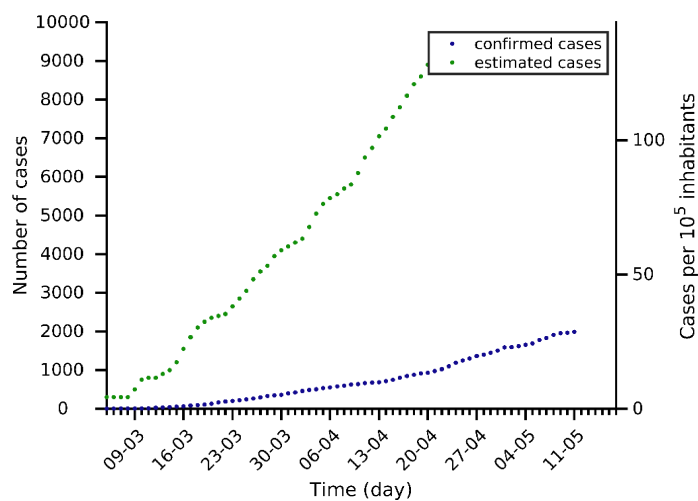
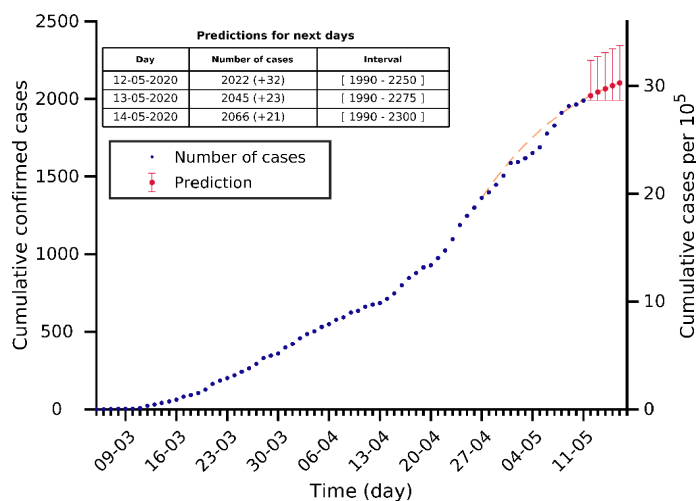
Greece 11-05-2020. Population: 10.4M. Current cumulated incidence: 26/10⁵



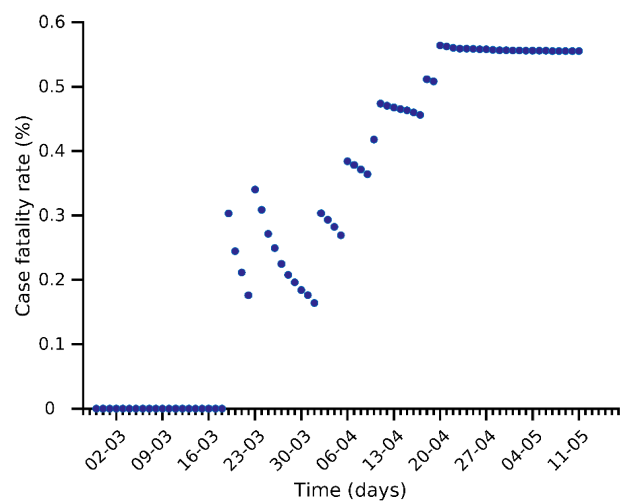
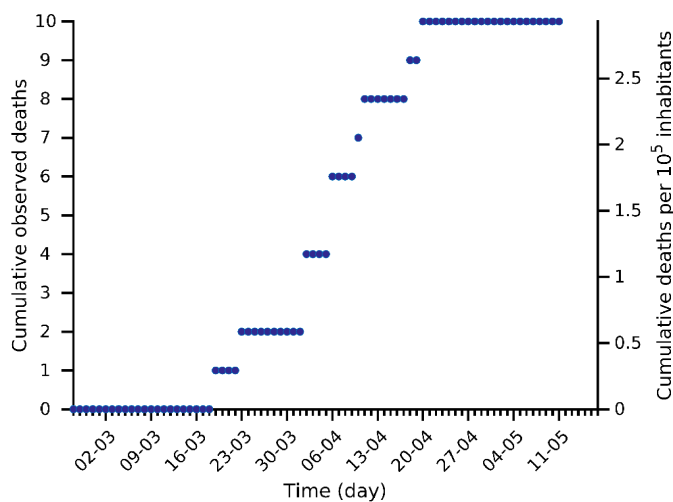
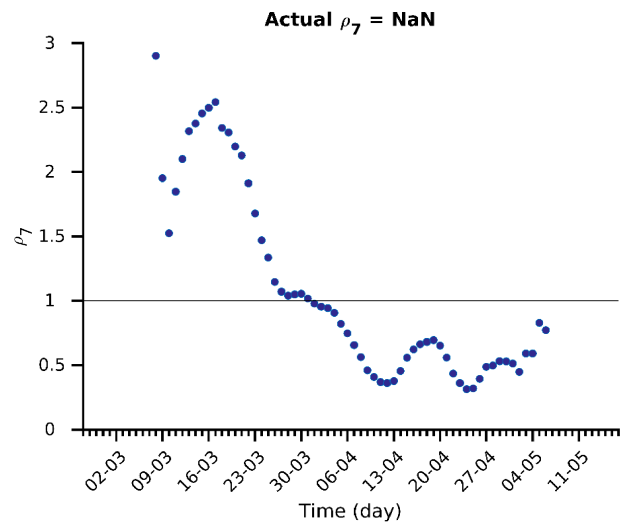
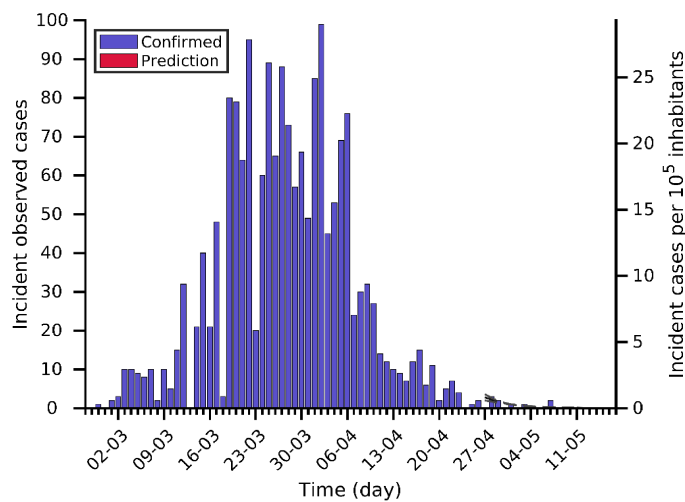
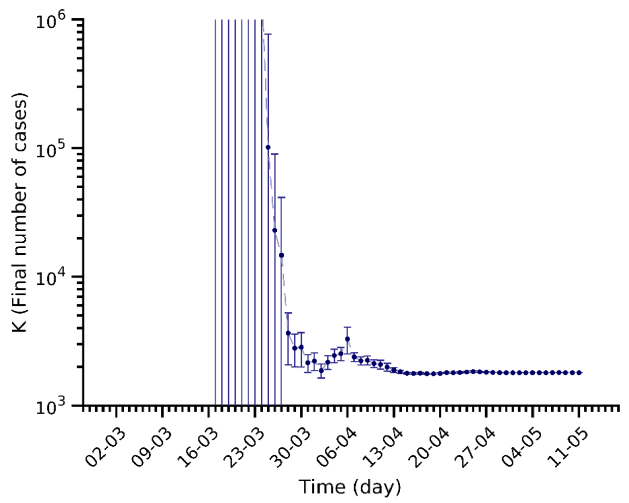
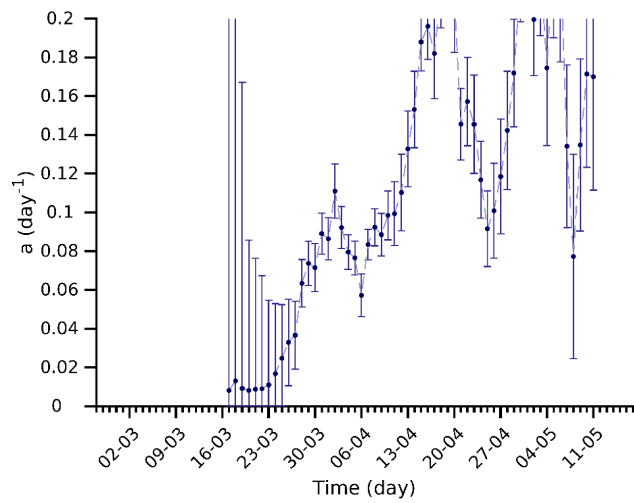
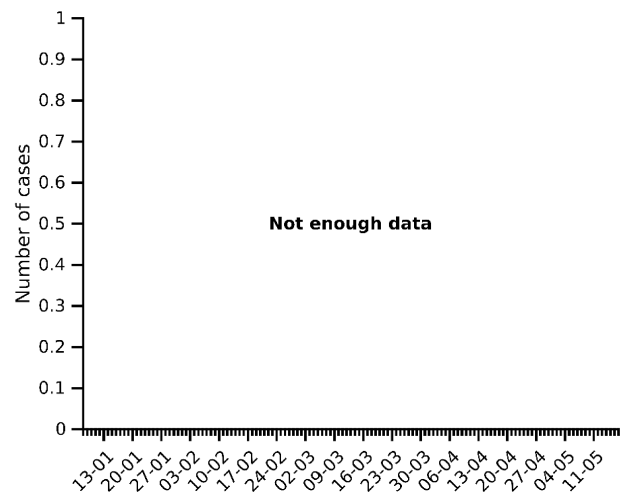
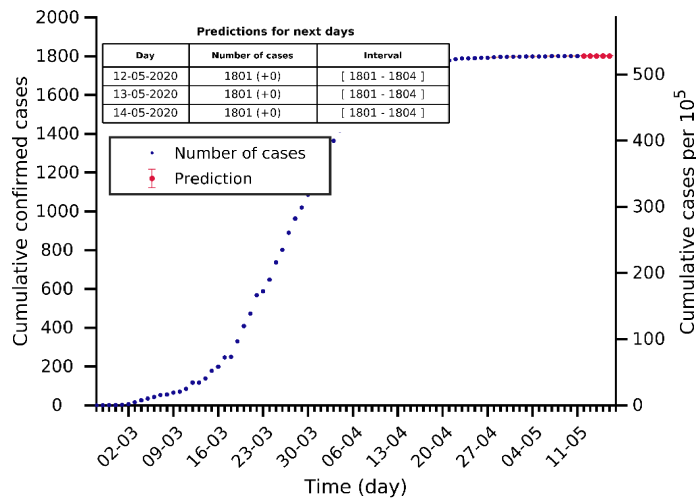
Croatia 11-05-2020. Population: 4.1M. Current cumulated incidence: 53/10⁵



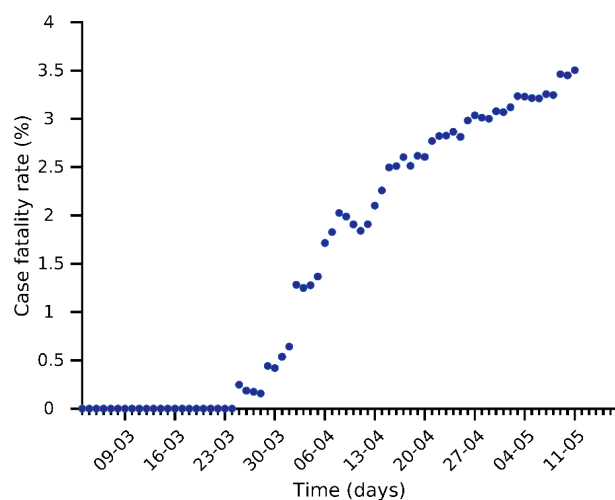
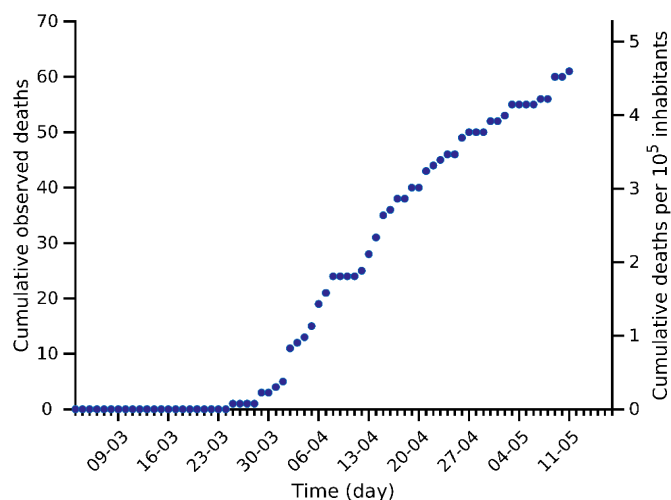
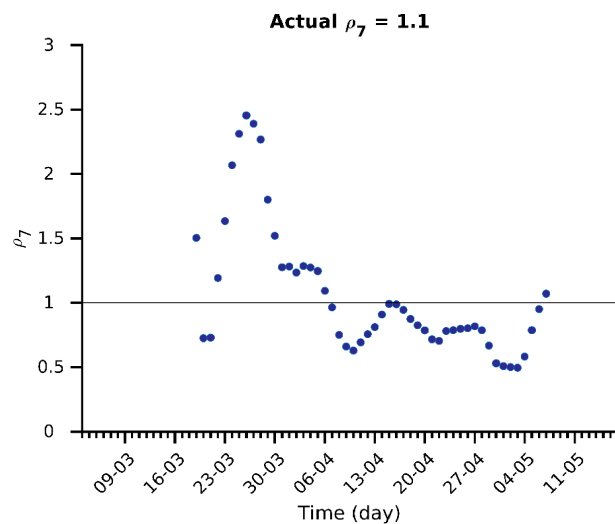
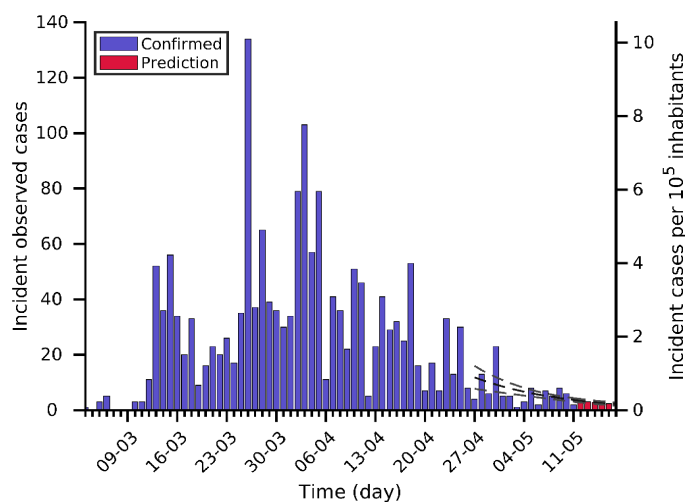
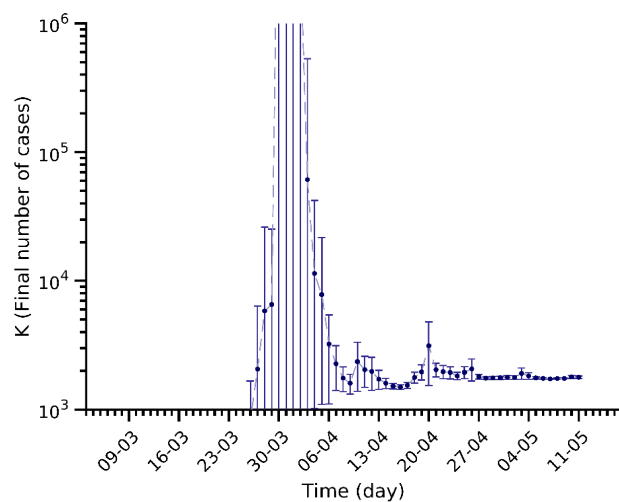
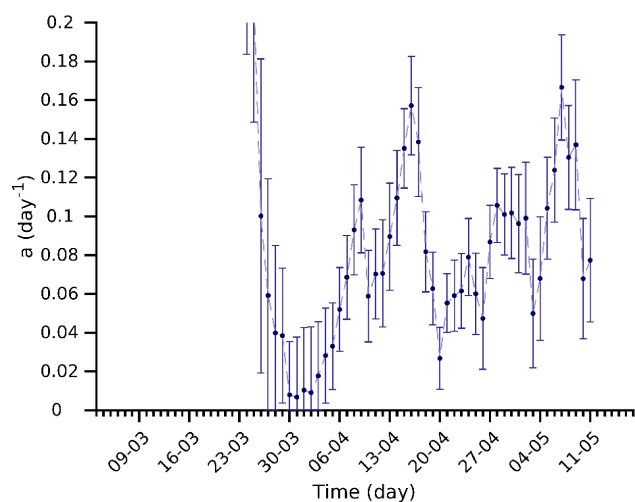
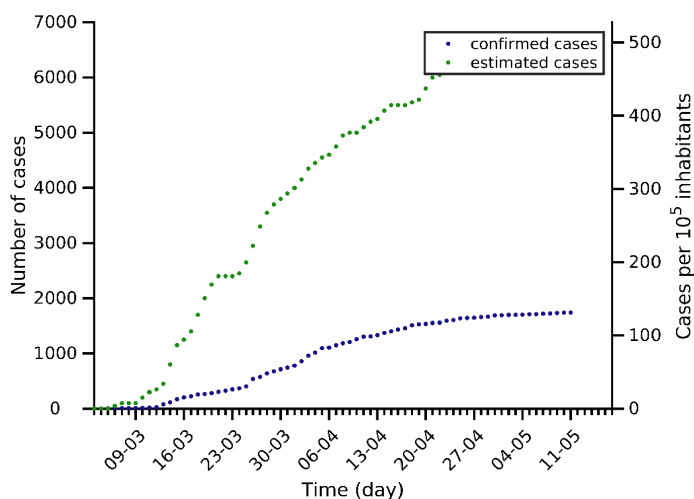
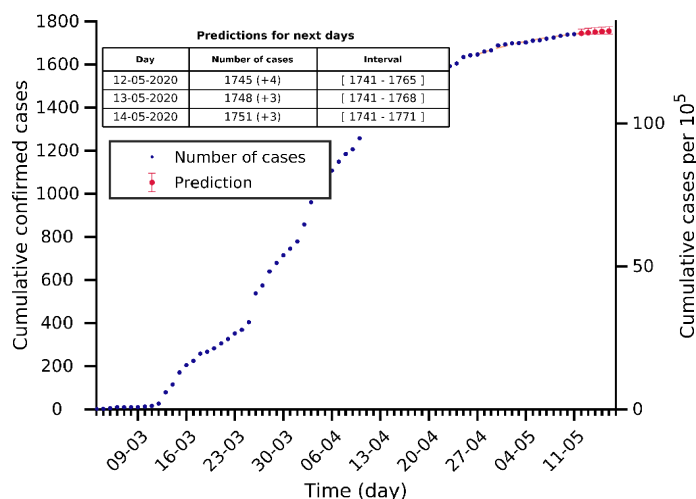
Bulgaria 11-05-2020. Population: 6.9M. Current cumulated incidence: 29/10⁵



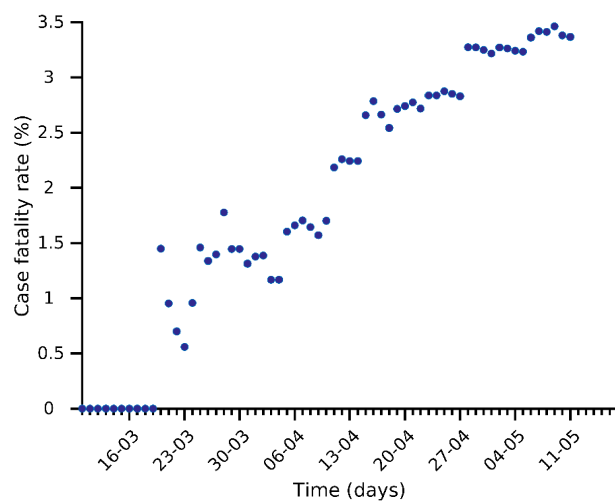
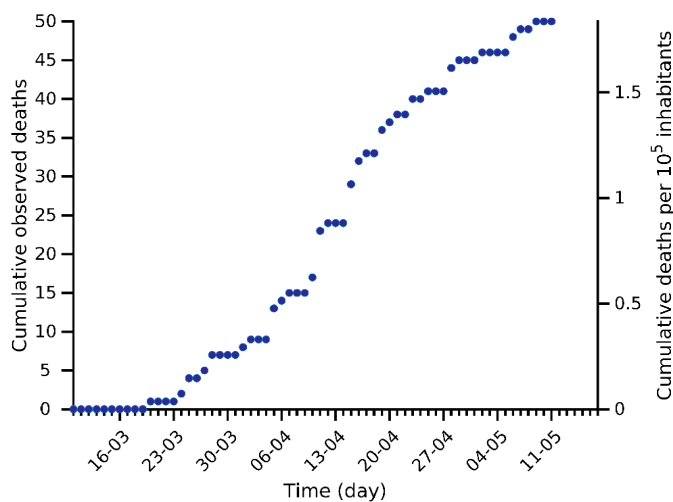
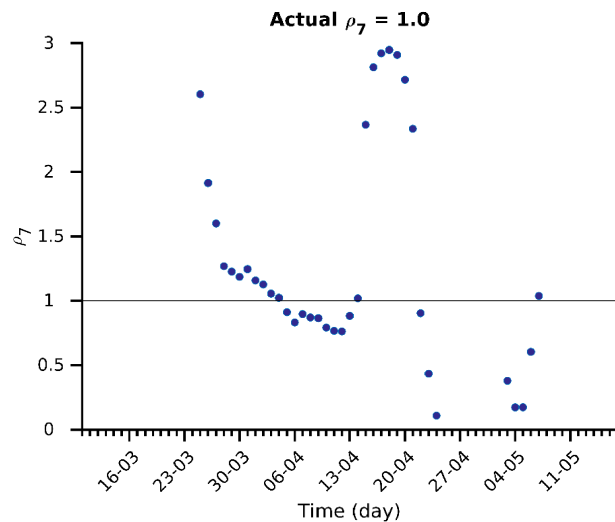
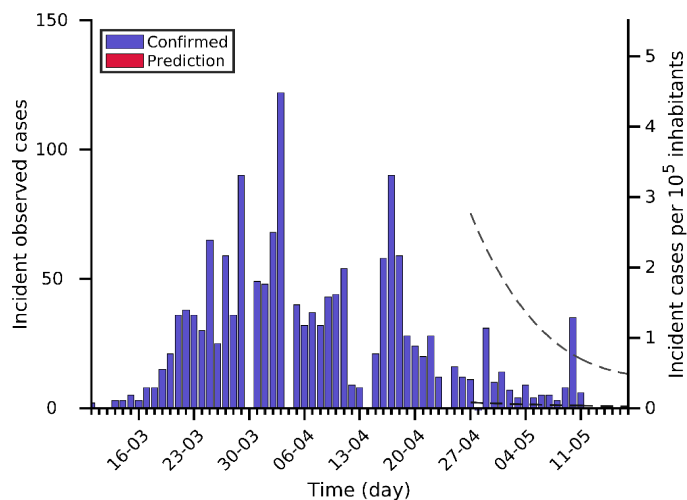
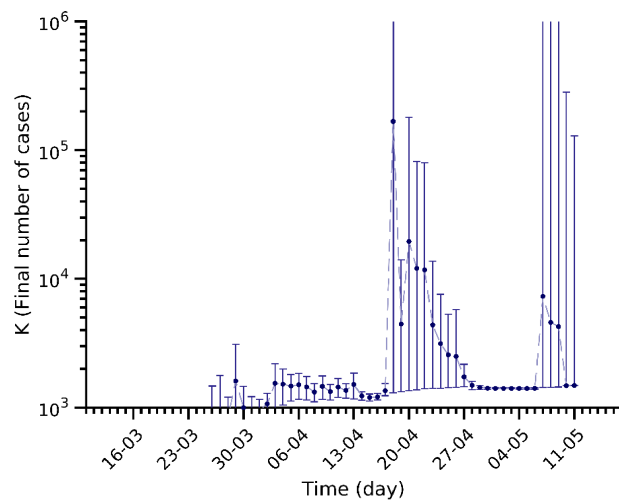
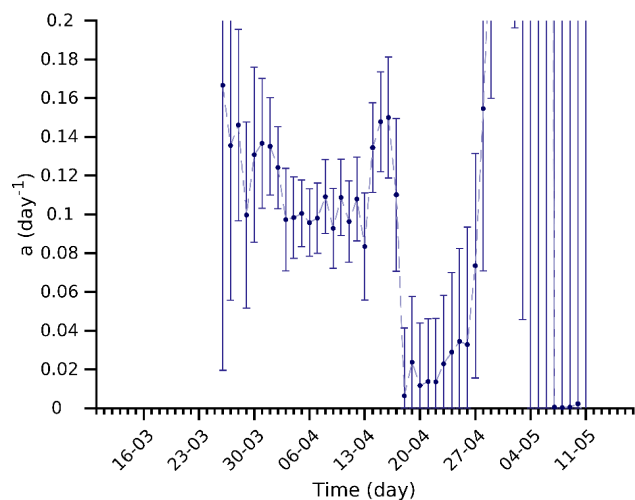
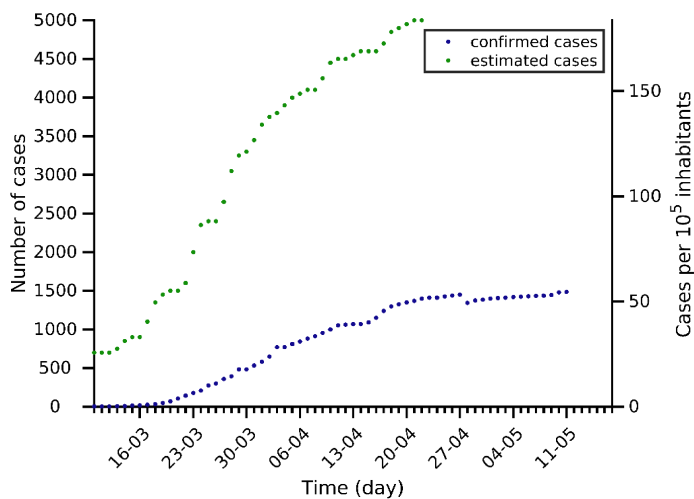
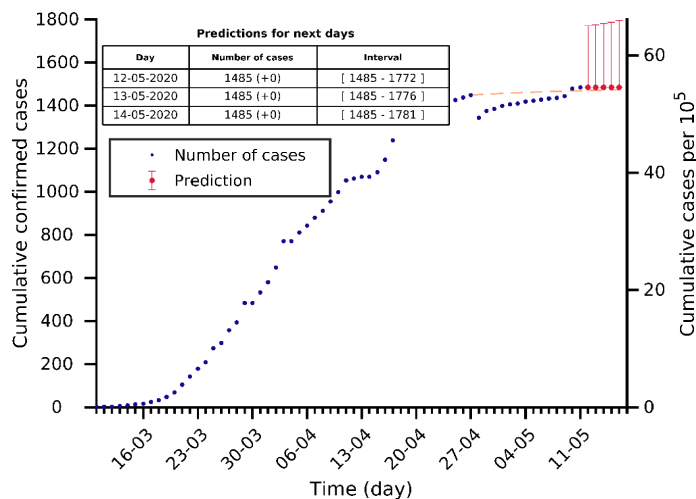
Iceland 11-05-2020. Population: 0.3M. Current cumulated incidence: 528/10⁵



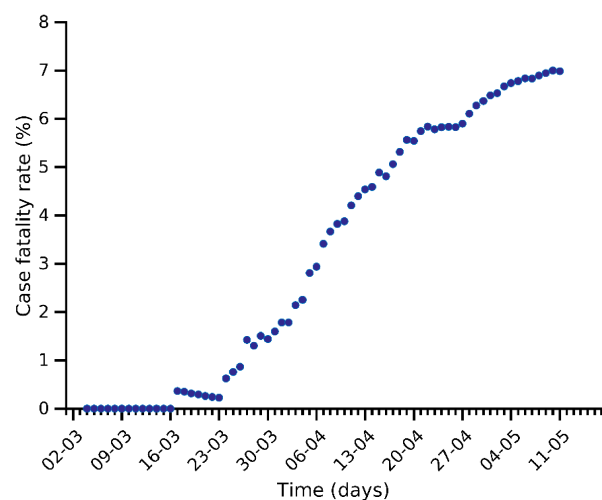
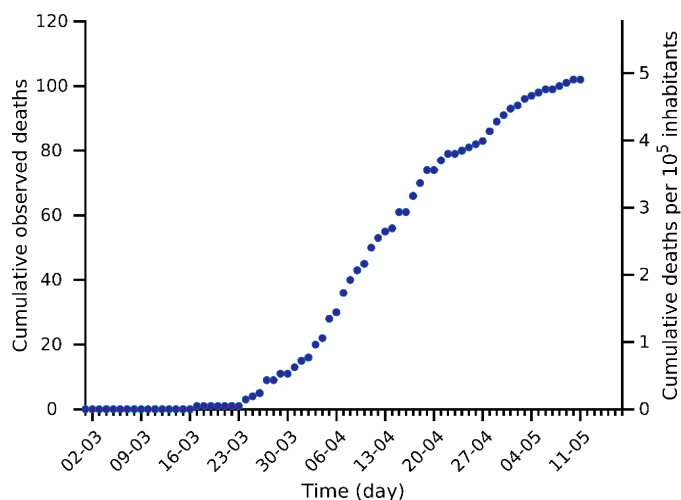
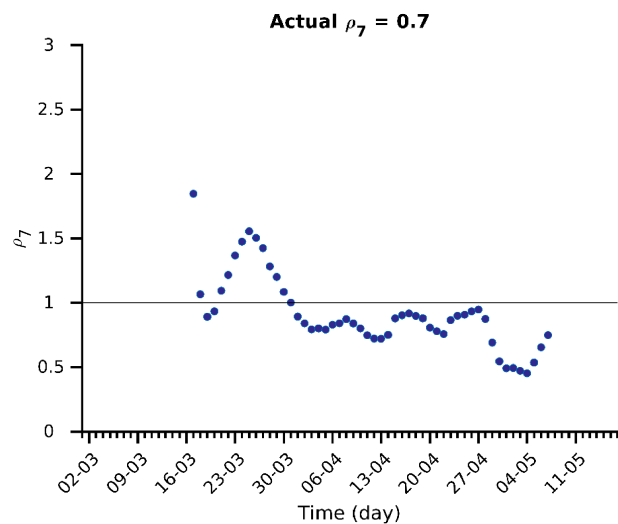
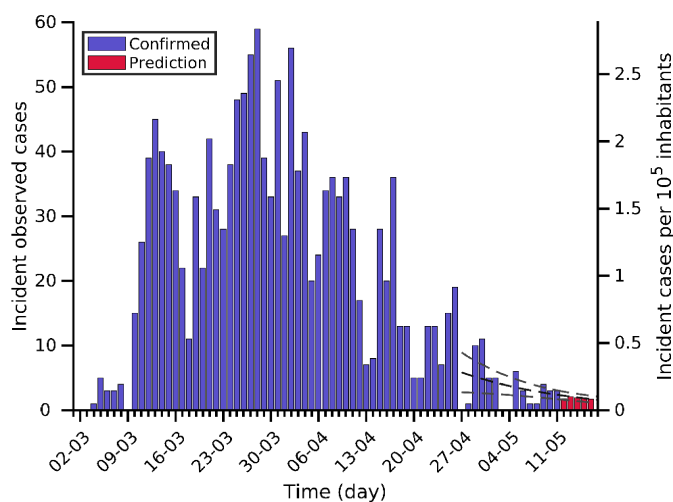
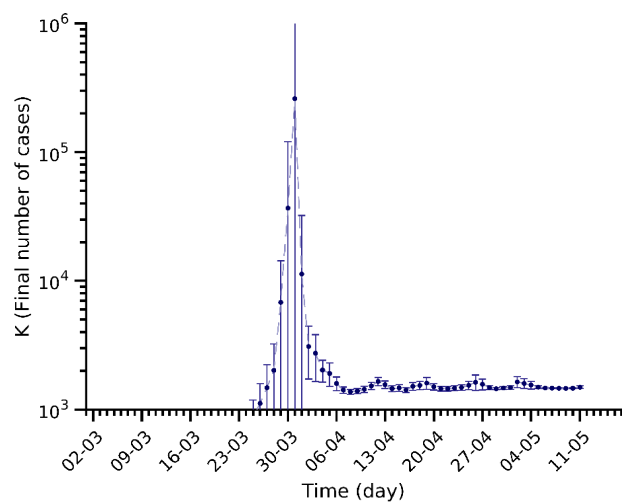
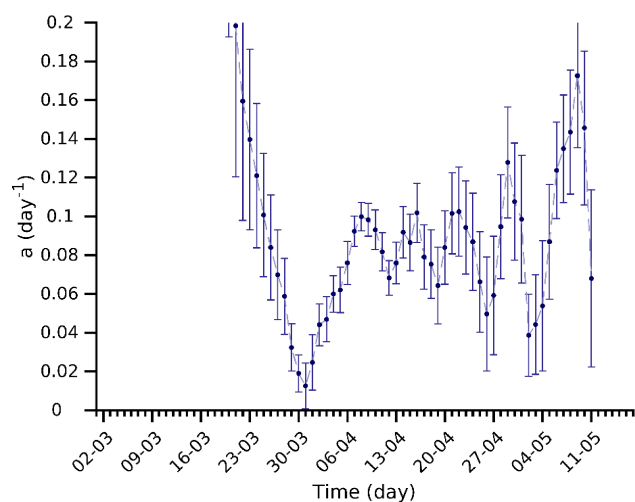
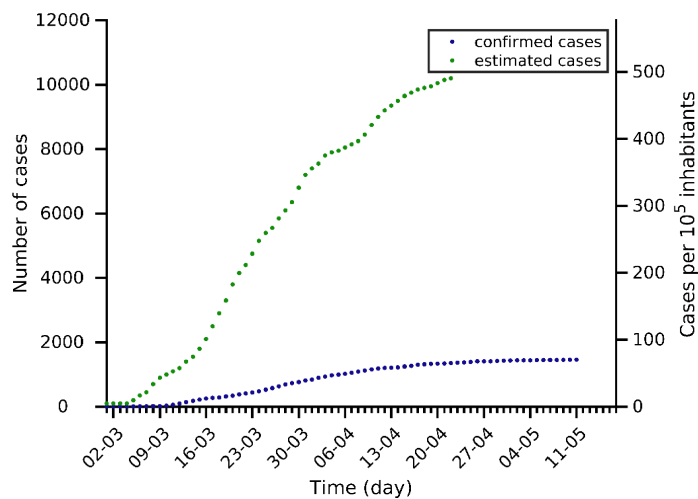
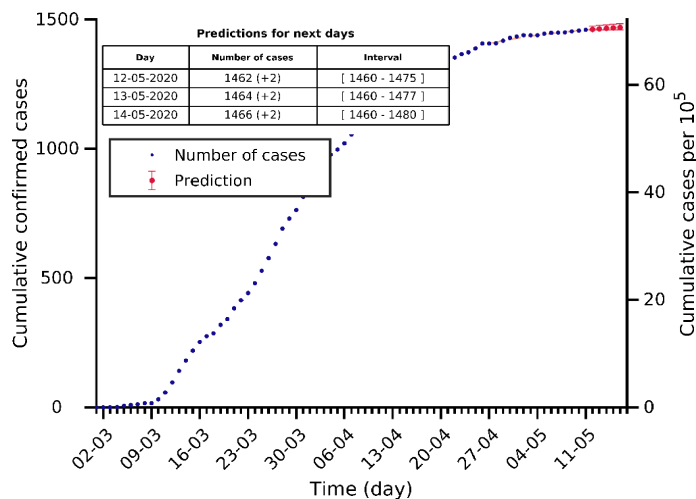
Estonia 11-05-2020. Population: 1.3M. Current cumulated incidence: 131/10⁵



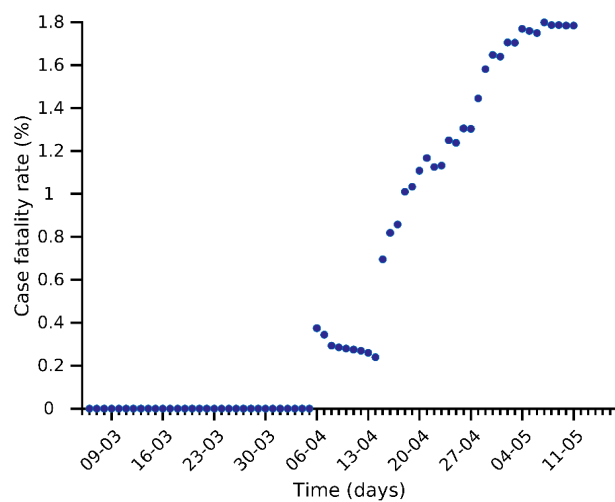
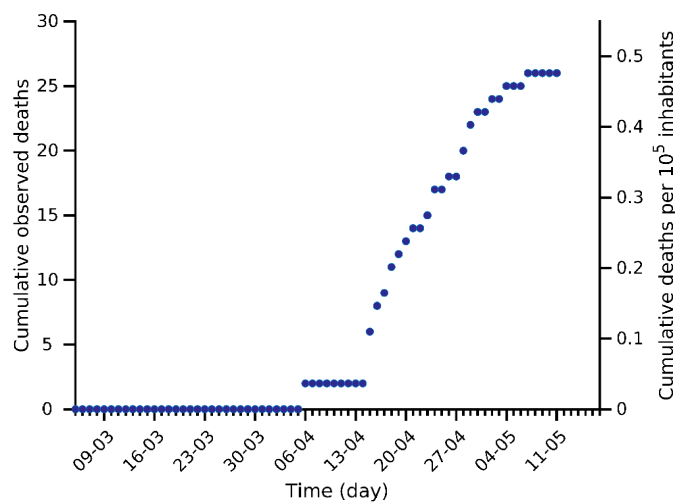
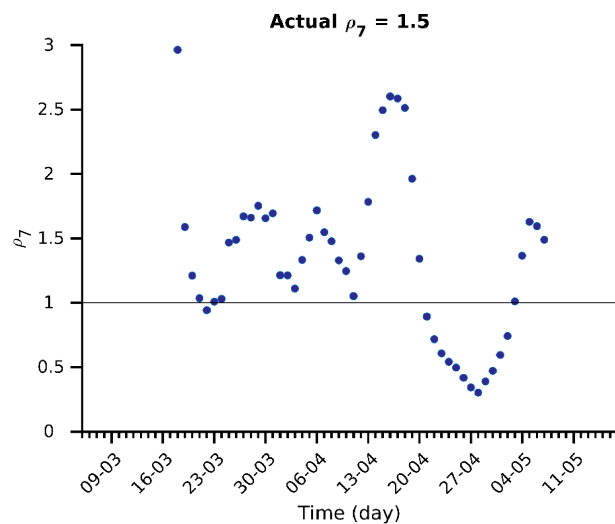
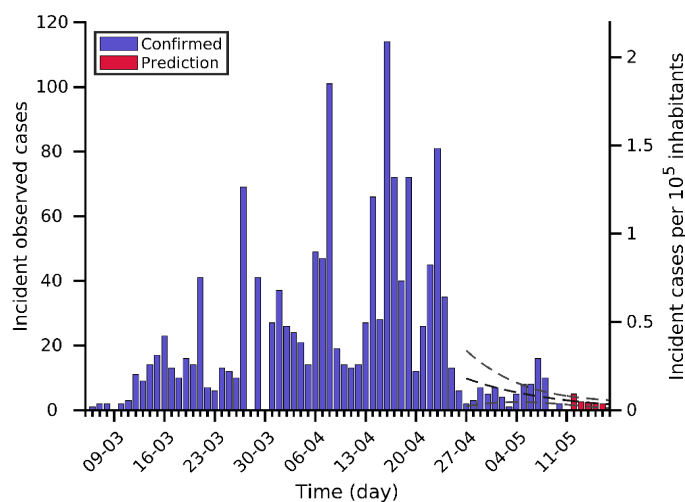
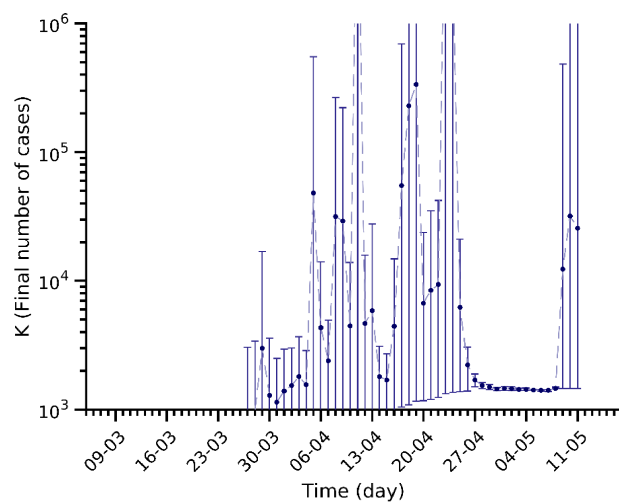
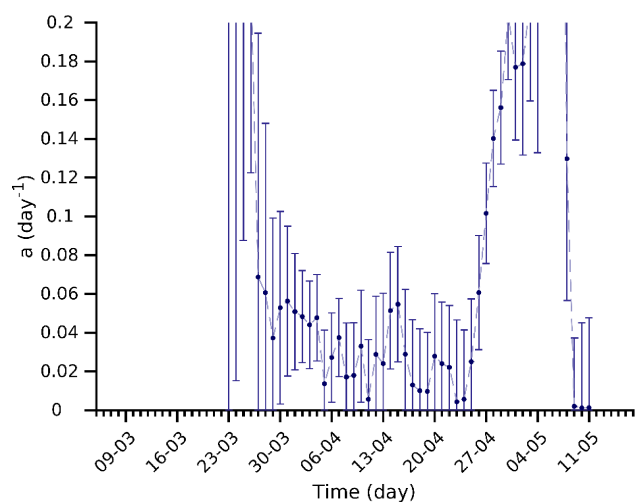
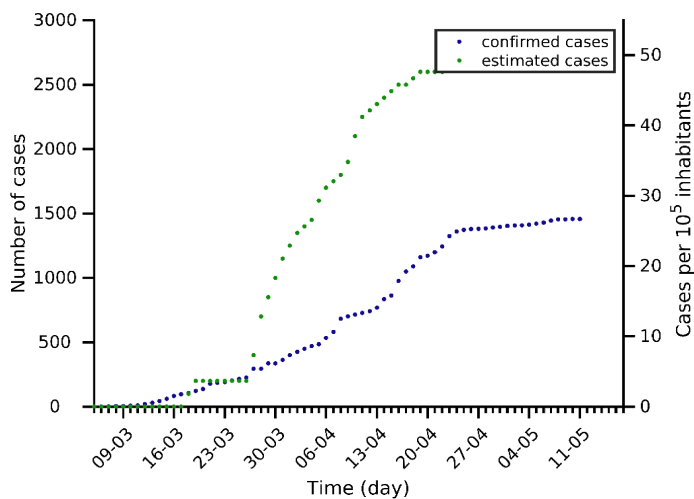
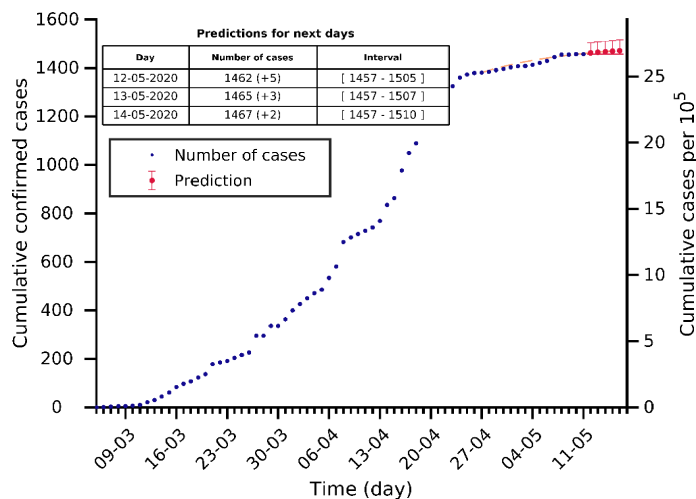
Lithuania 11-05-2020. Population: 2.7M. Current cumulated incidence: 55/10⁵



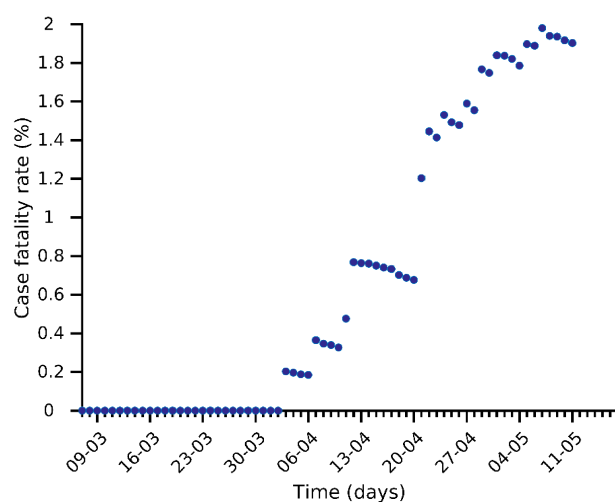
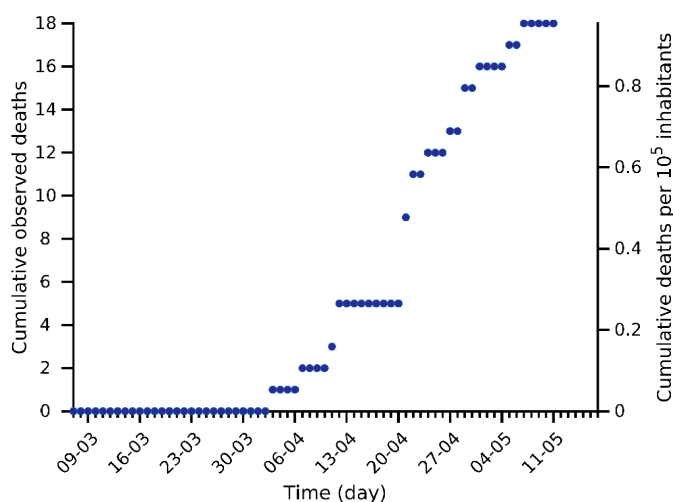
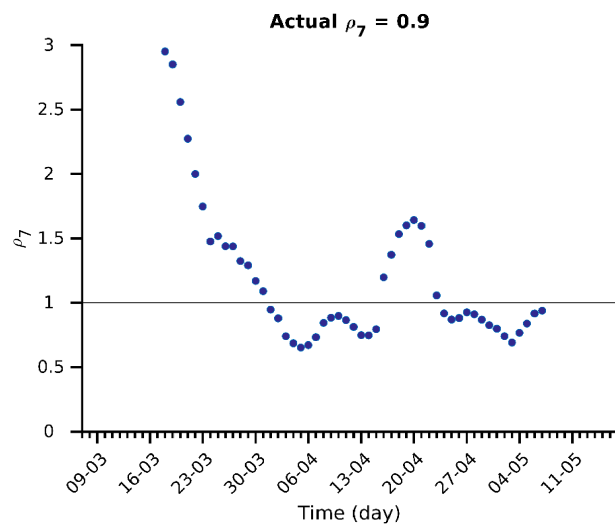
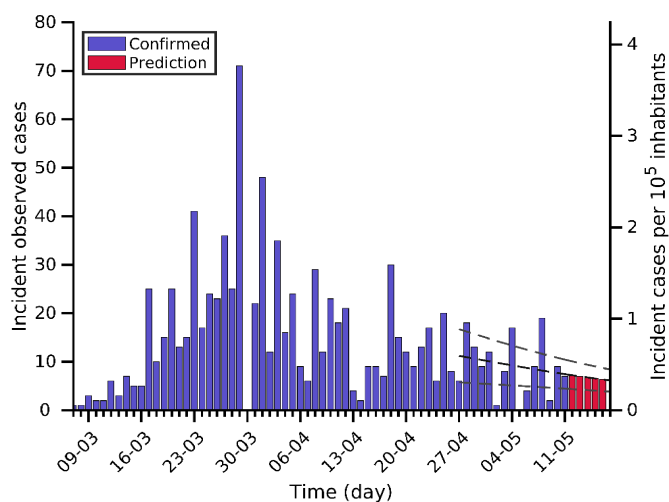
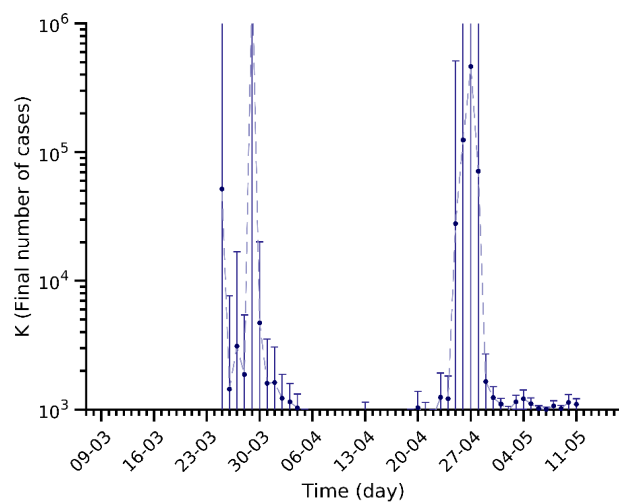
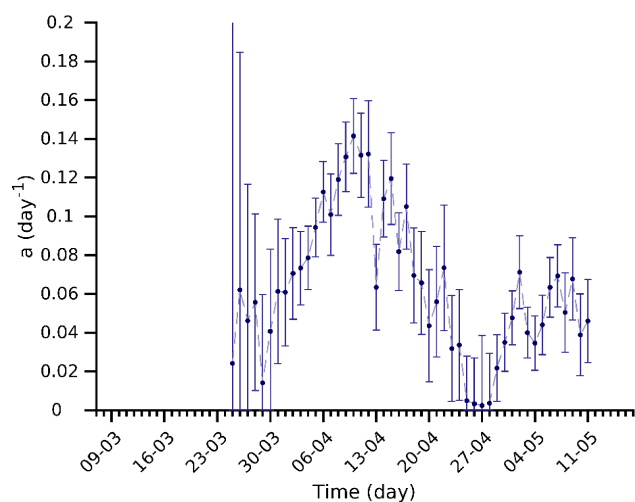
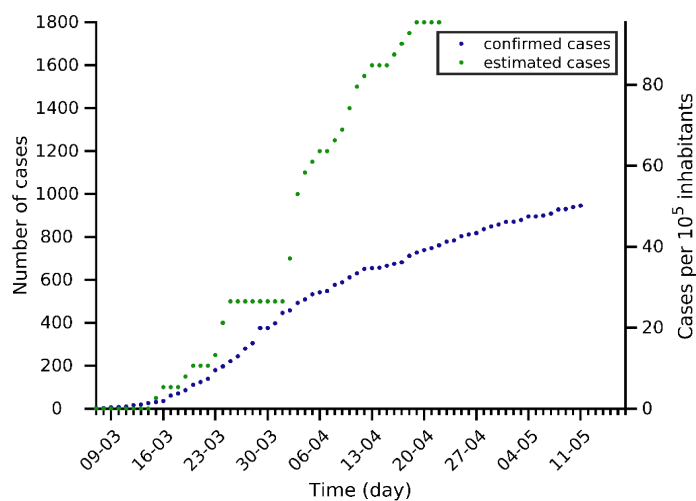
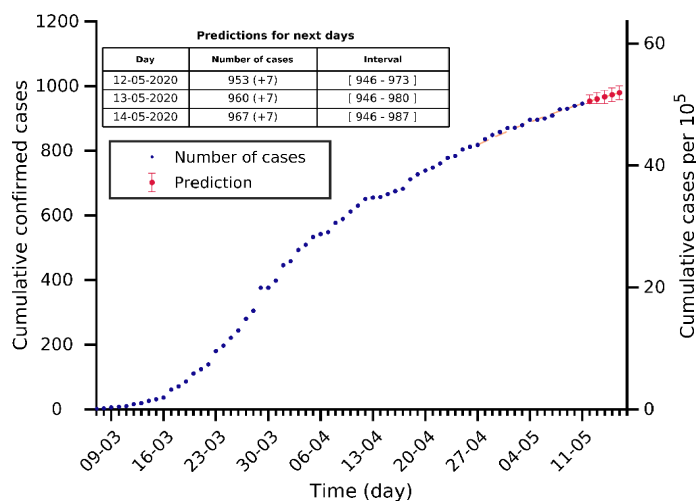
Slovenia 11-05-2020. Population: 2.1M. Current cumulated incidence: 70/10⁵



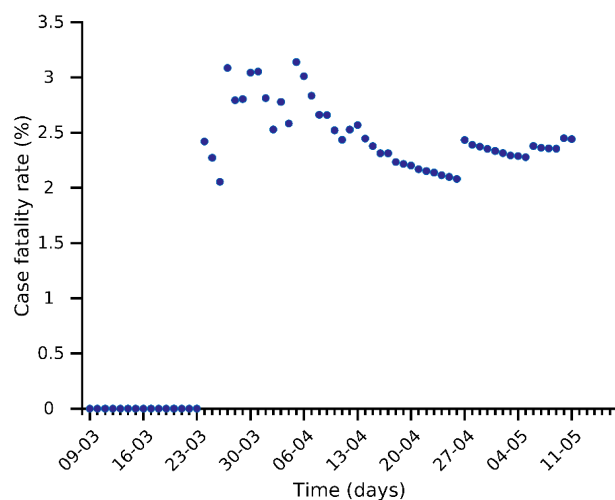
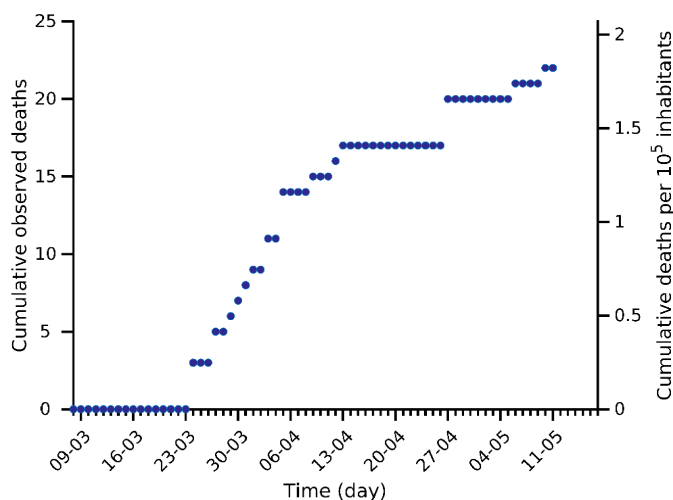
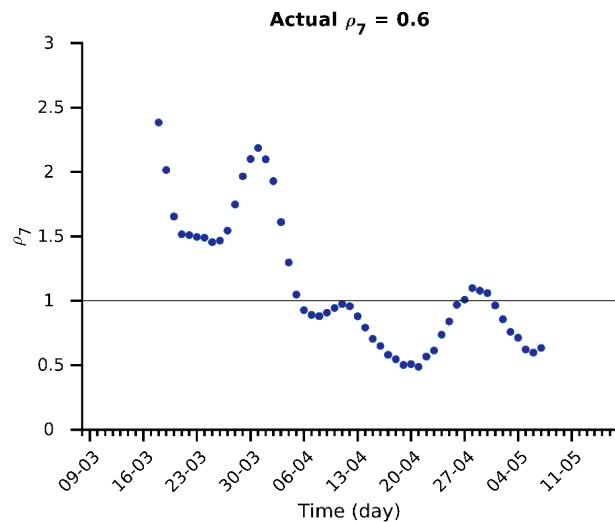
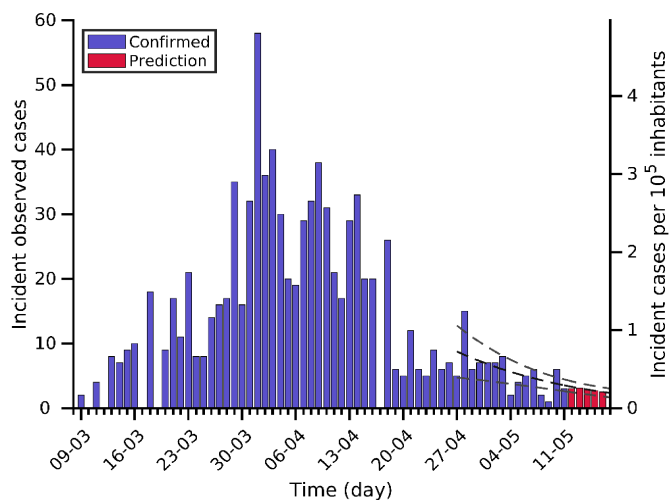
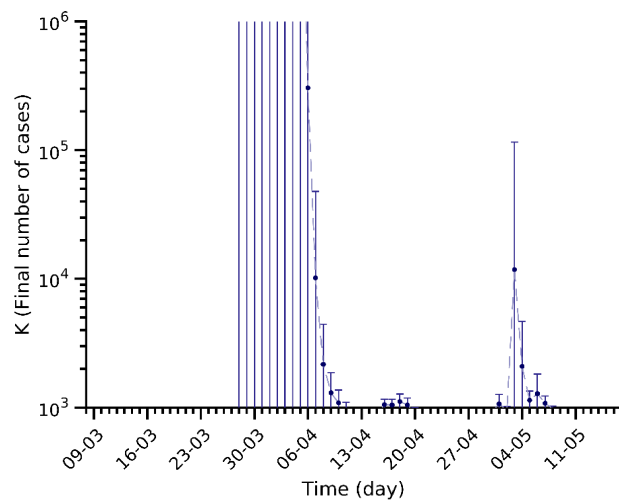
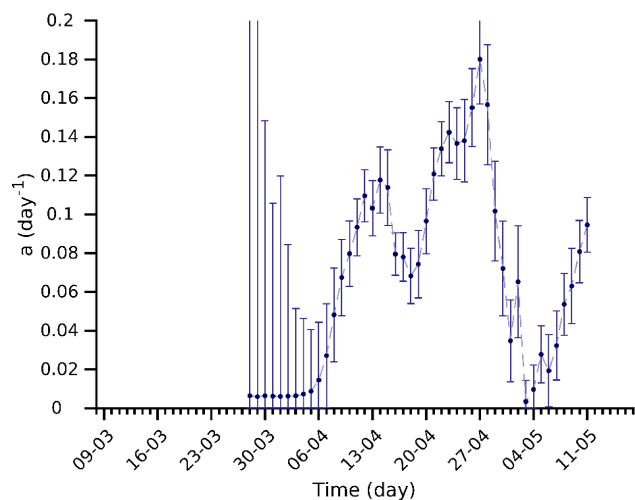
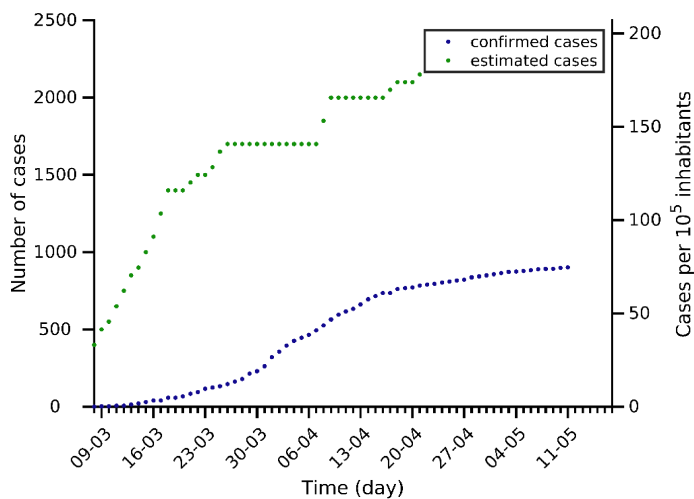
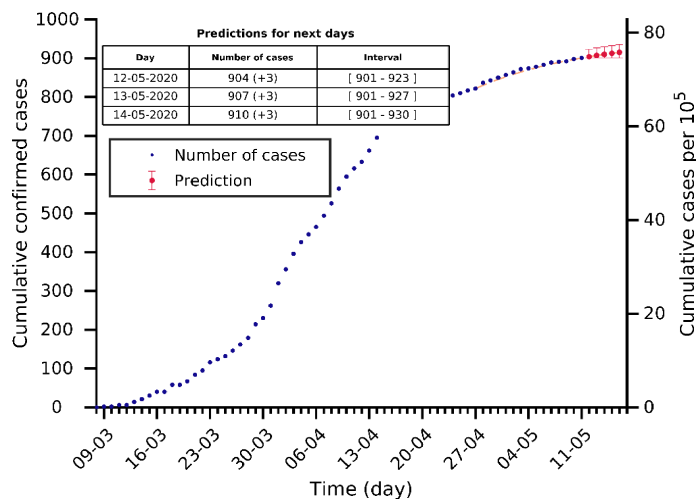
Slovakia 11-05-2020. Population: 5.5M. Current cumulated incidence: $27/10^5$



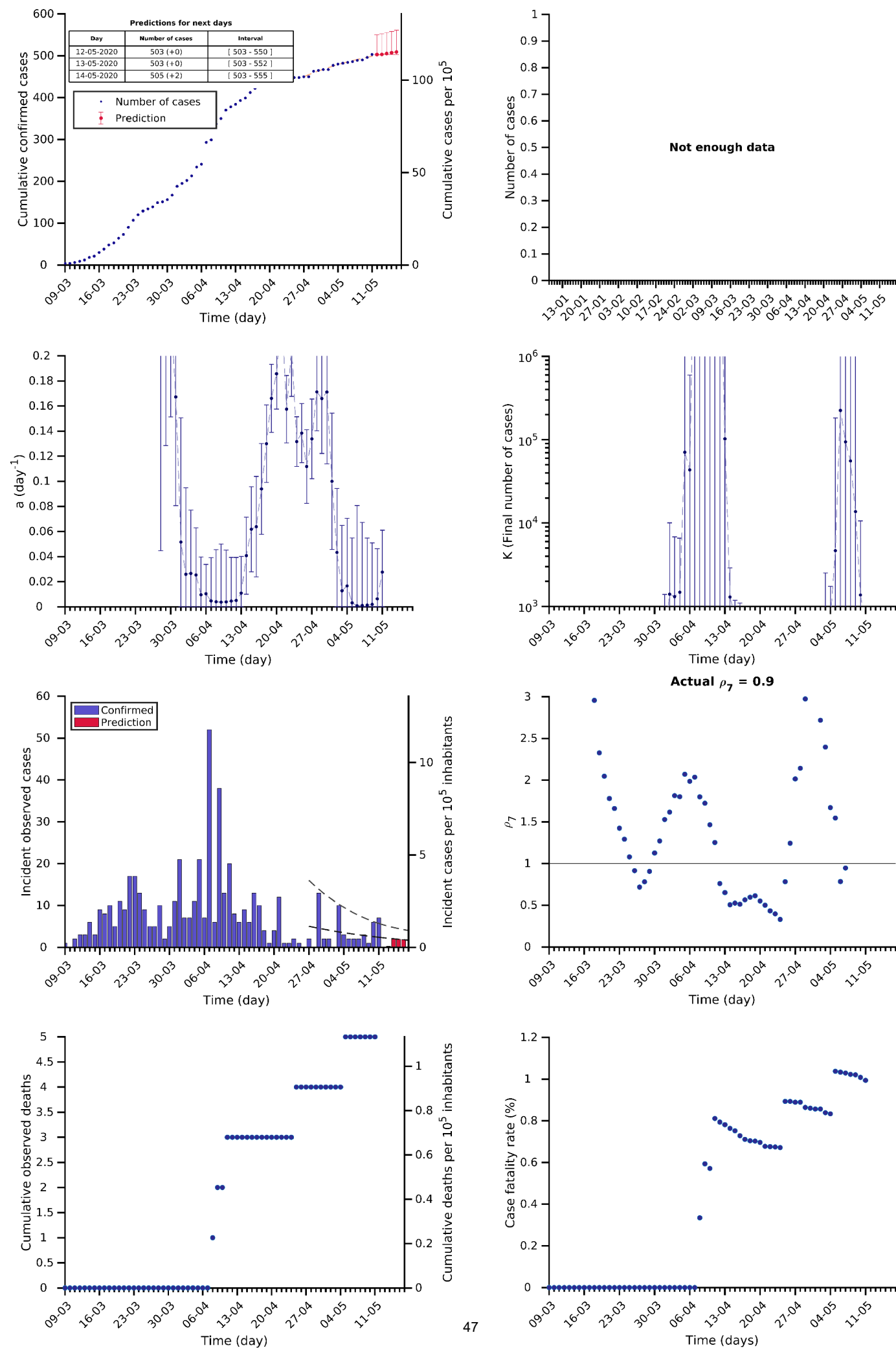
Latvia 11-05-2020. Population: 1.9M. Current cumulated incidence: 50/10⁵



Cyprus 11-05-2020. Population: 1.2M. Current cumulated incidence: 75/10⁵



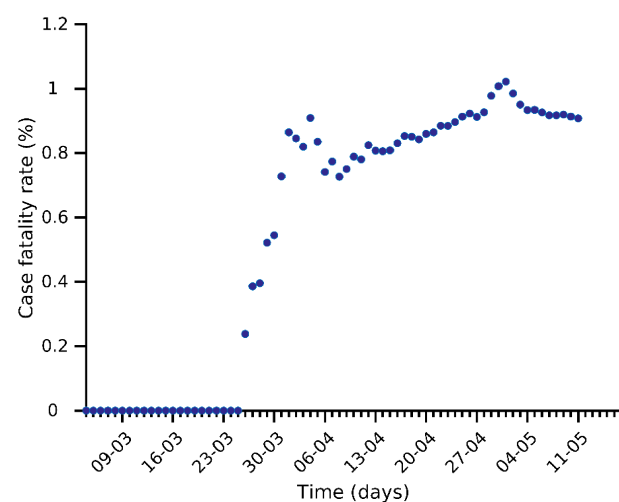
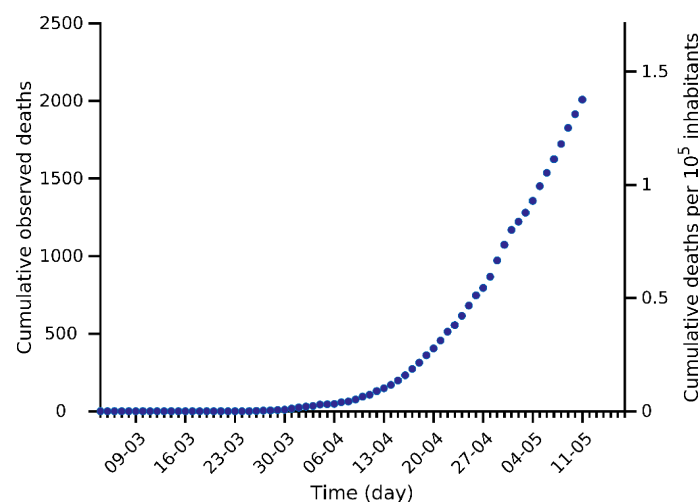
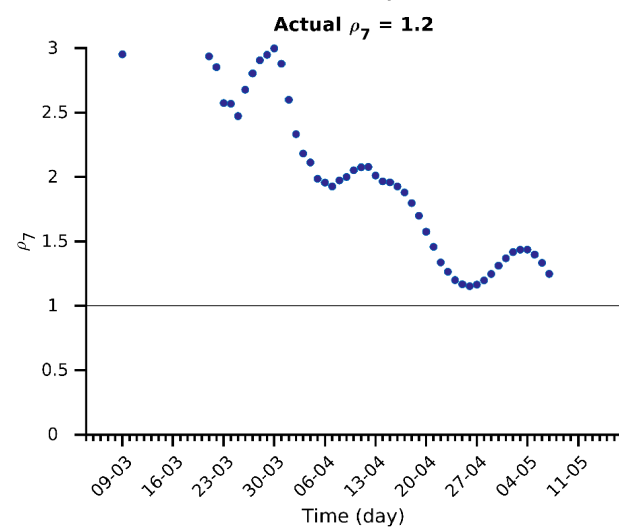
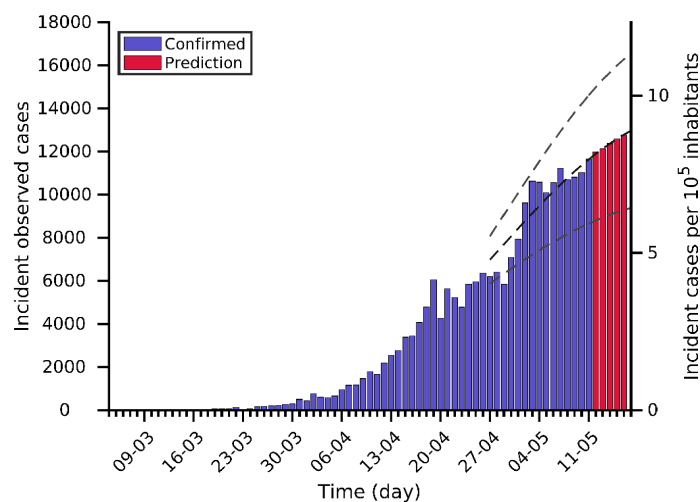
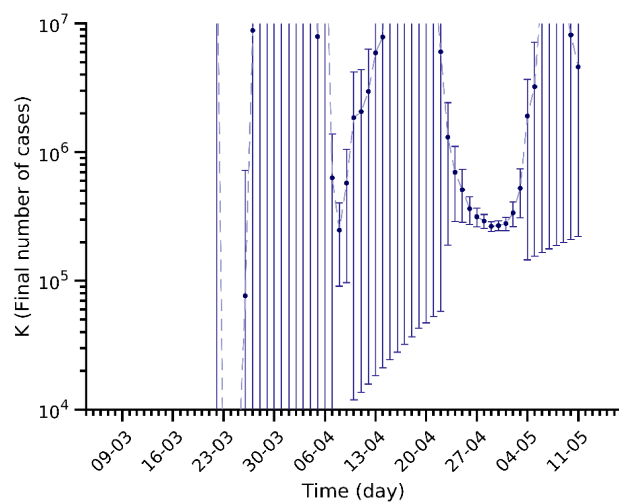
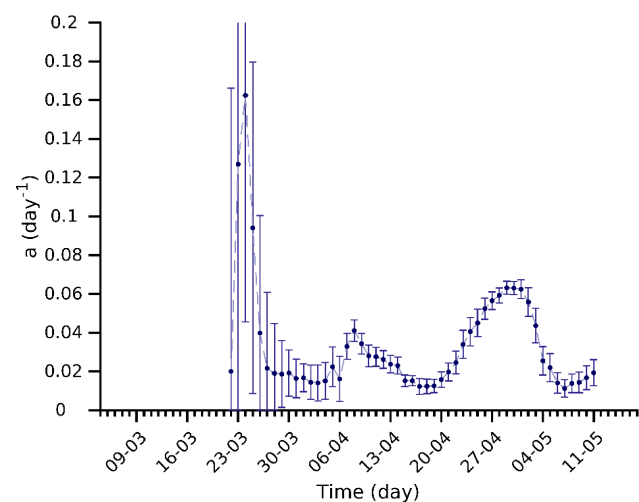
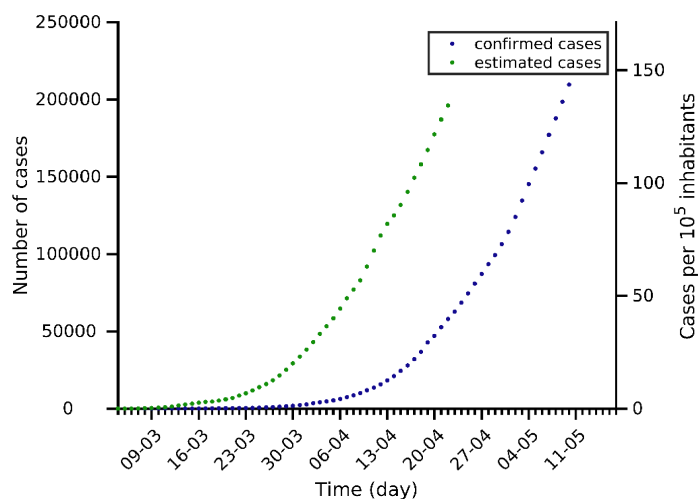
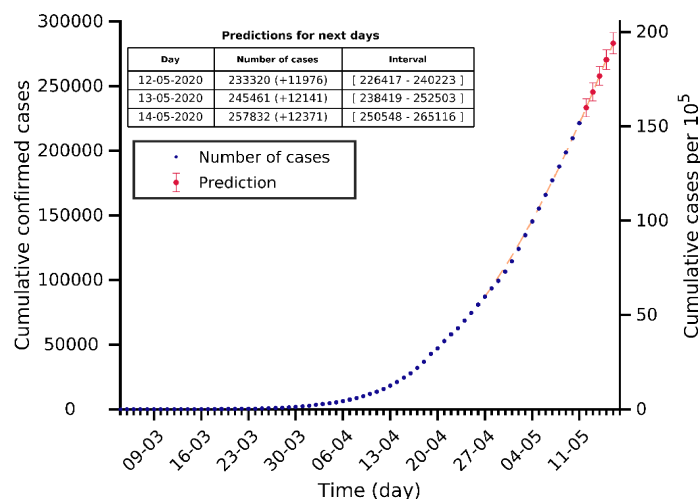
Malta 11-05-2020. Population: 0.4M. Current cumulated incidence: 114/10⁵



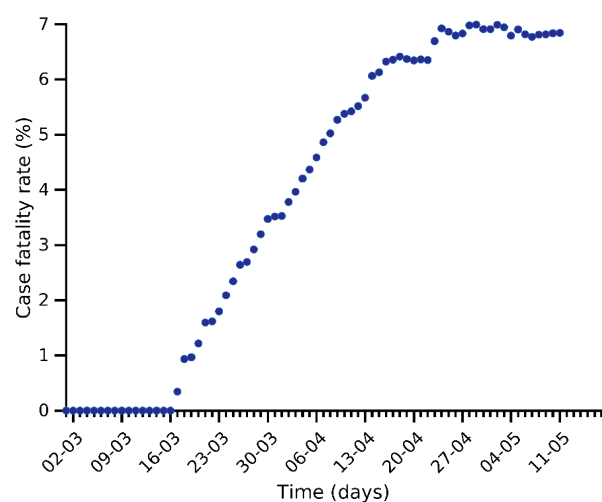
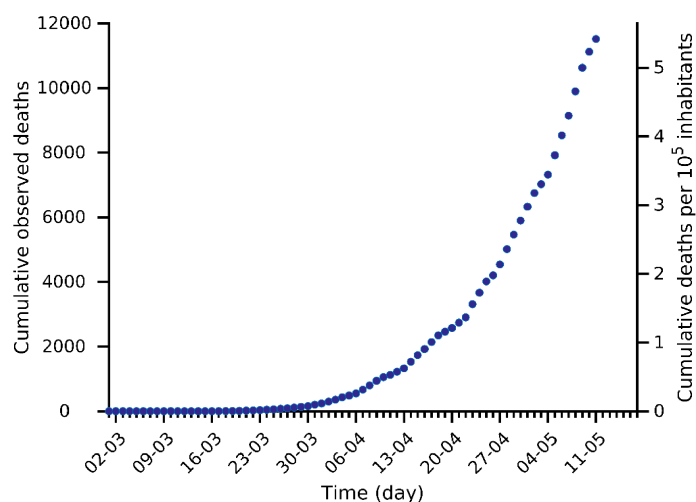
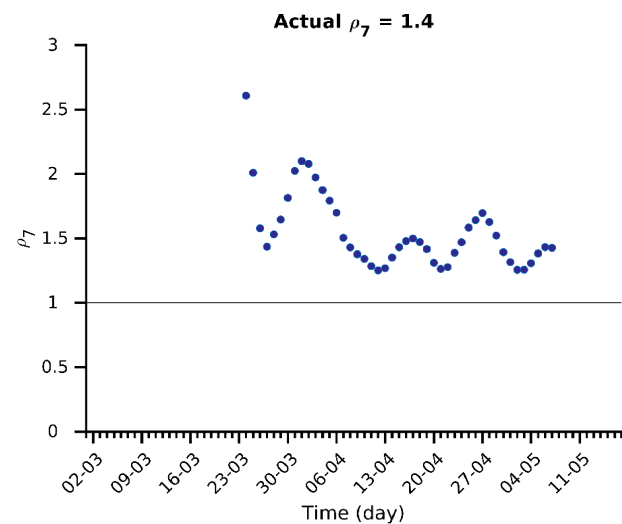
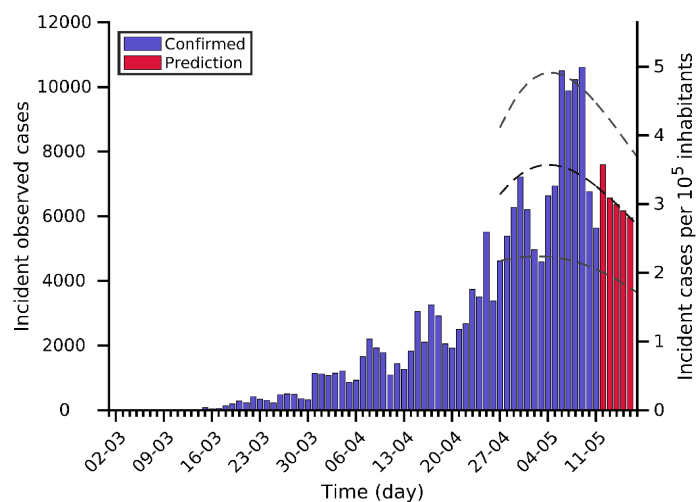
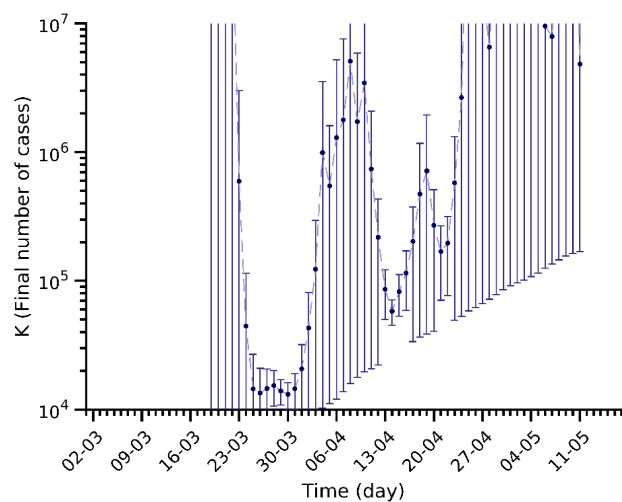
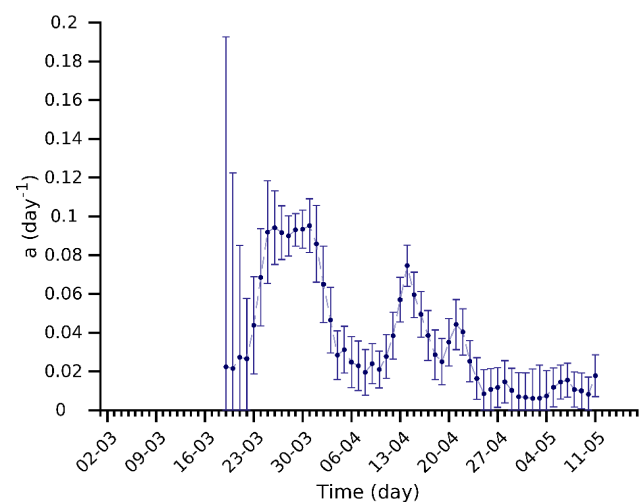
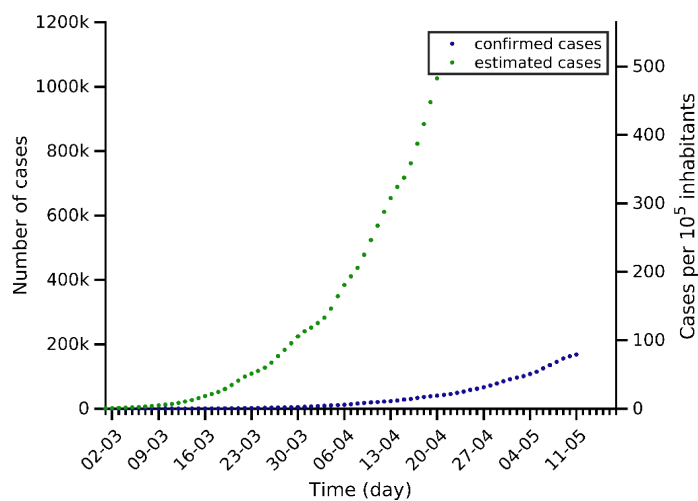
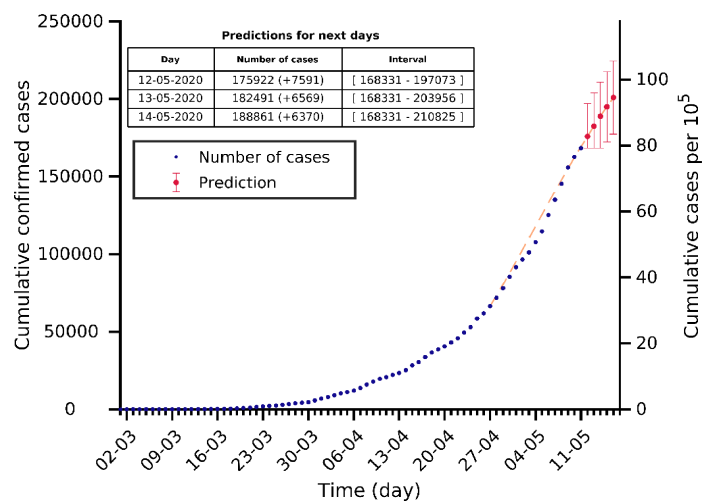
(2) Analysis and prediction of COVID-19 for other countries

Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

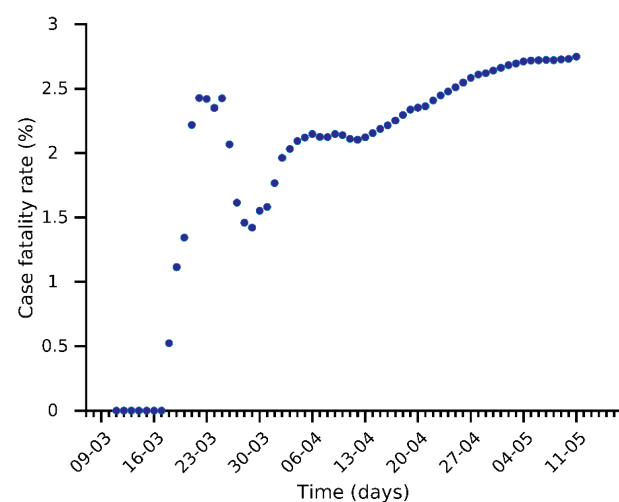
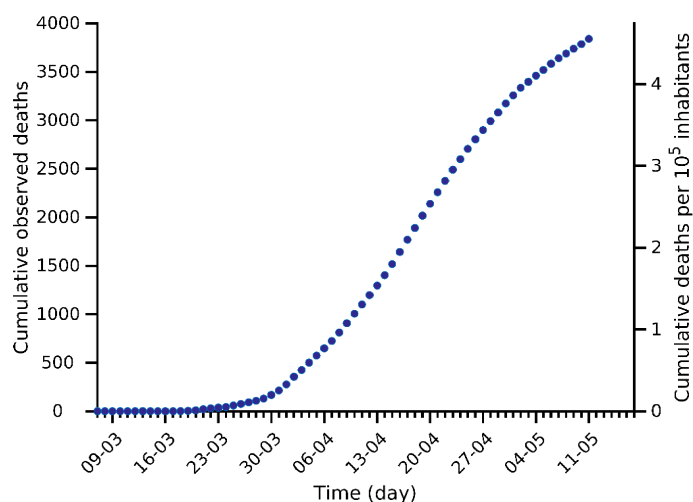
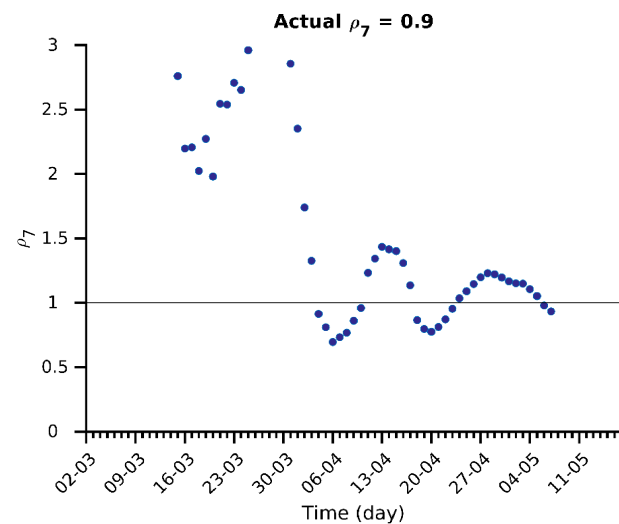
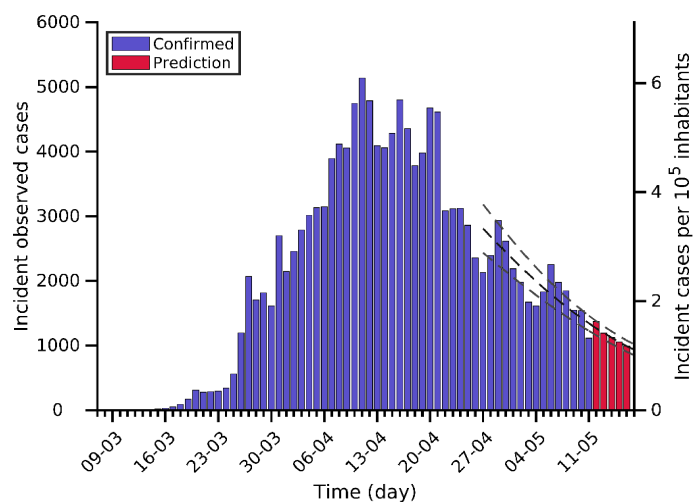
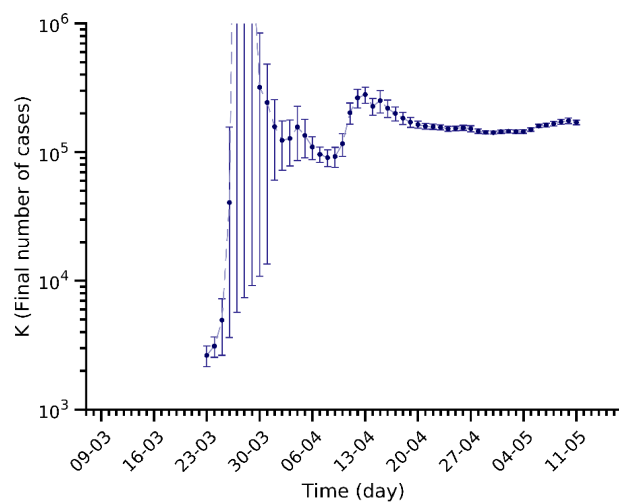
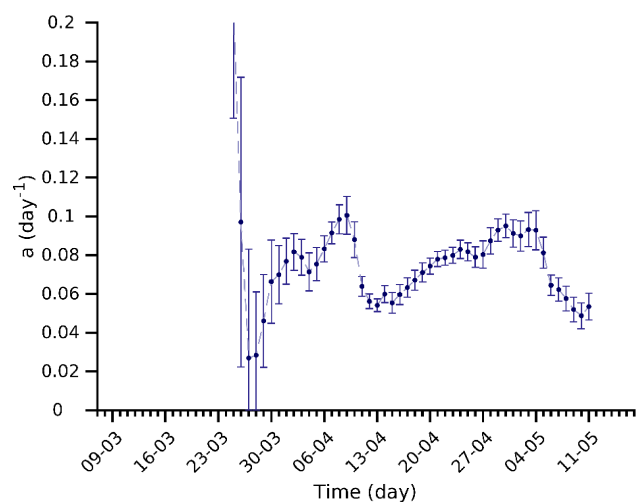
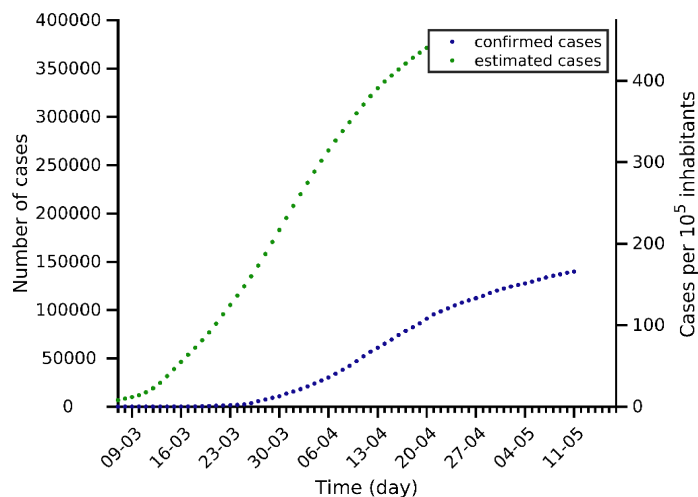
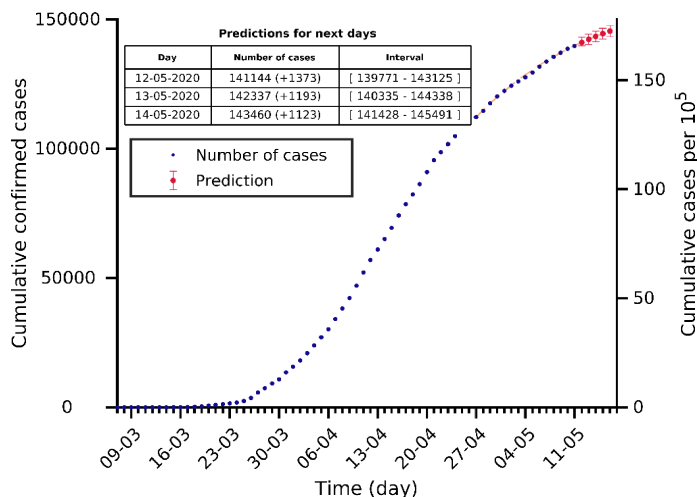
Russia 11-05-2020. Population: 145.9M. Current cumulated incidence: 152/10⁵



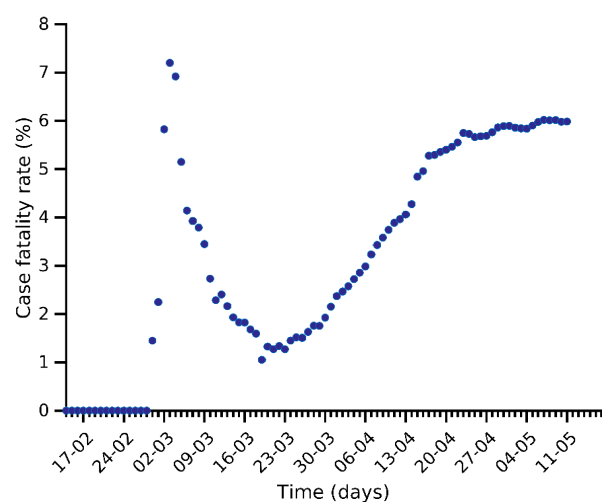
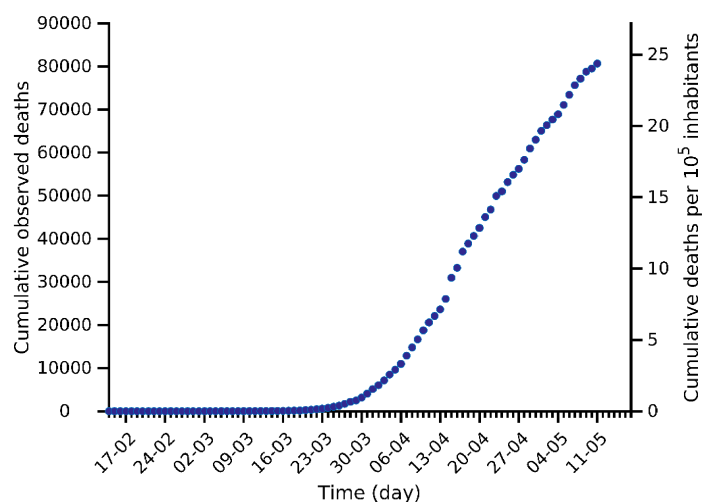
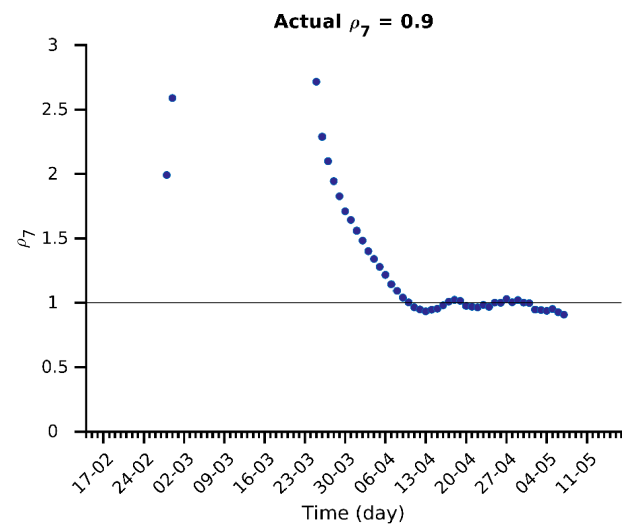
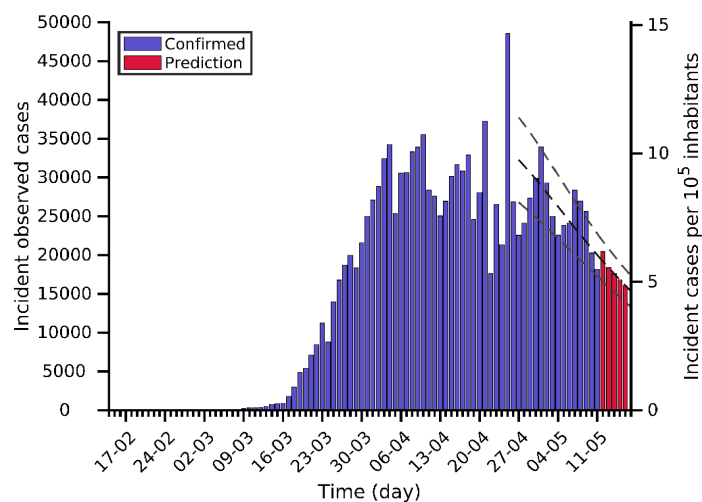
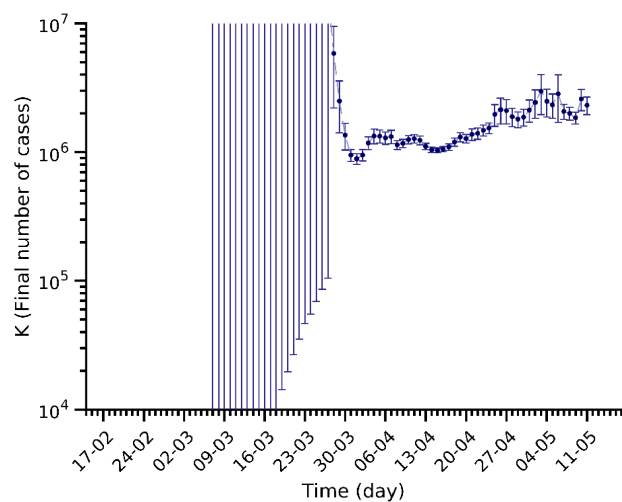
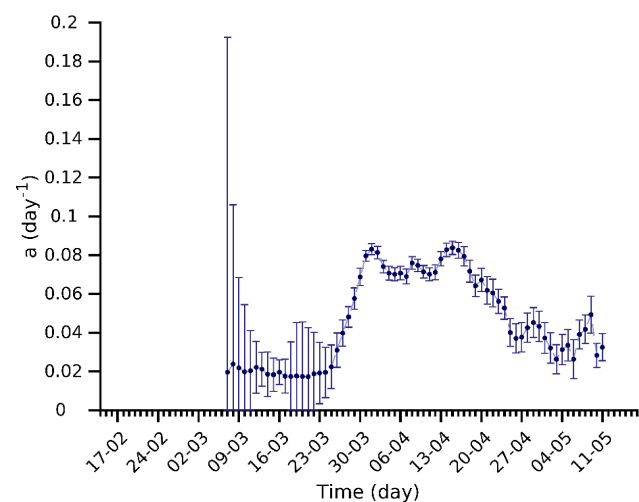
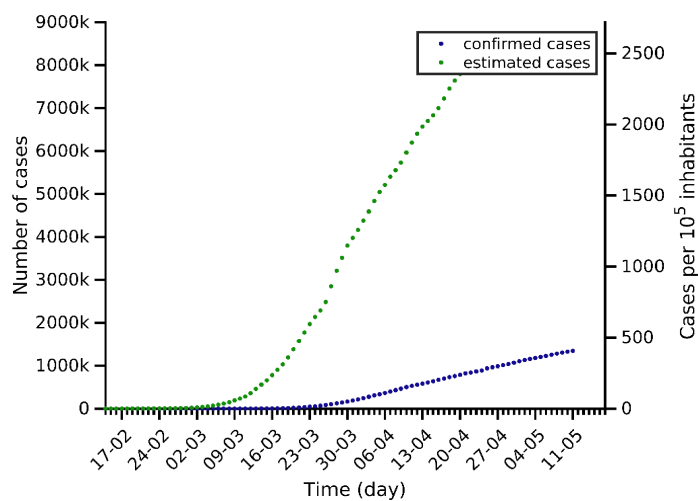
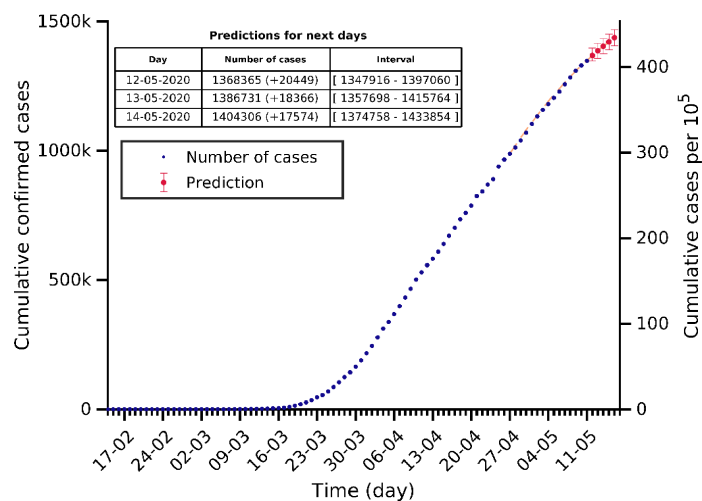
Brazil 11-05-2020. Population: 212.6M. Current cumulated incidence: 79/10⁵



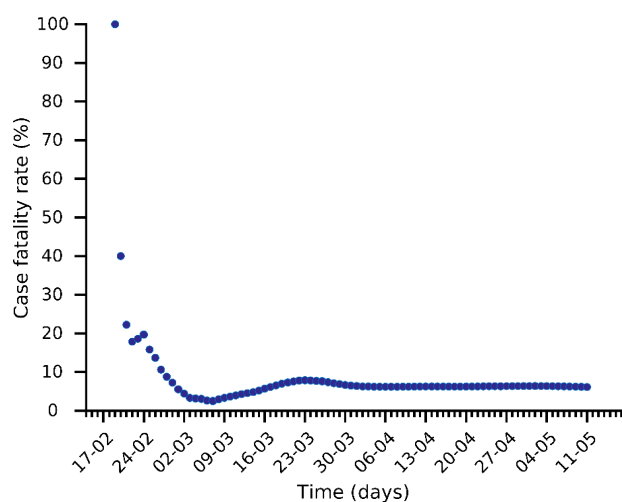
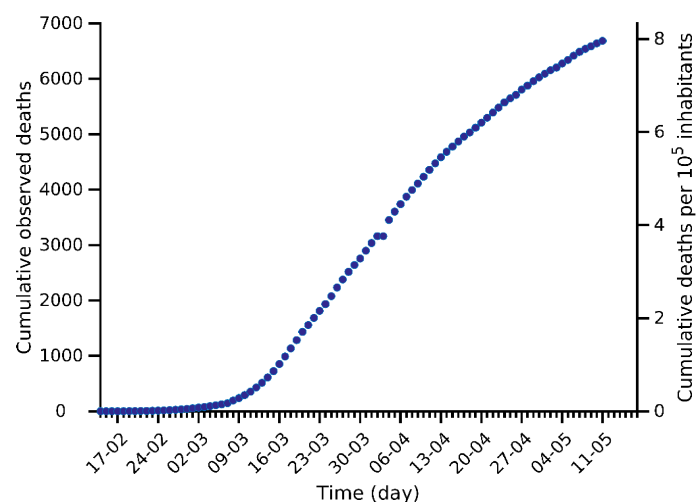
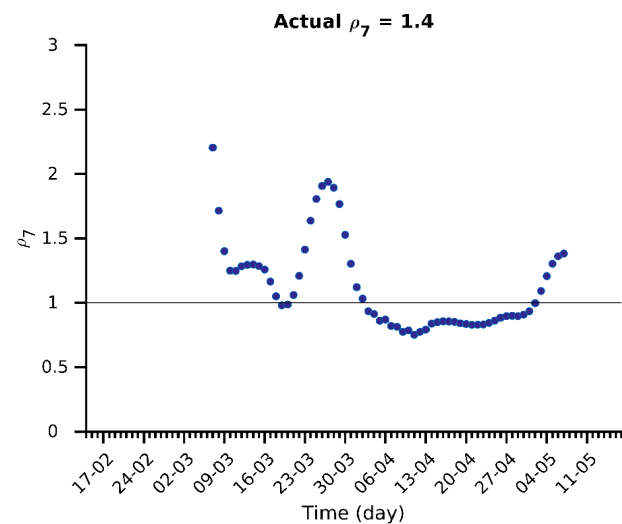
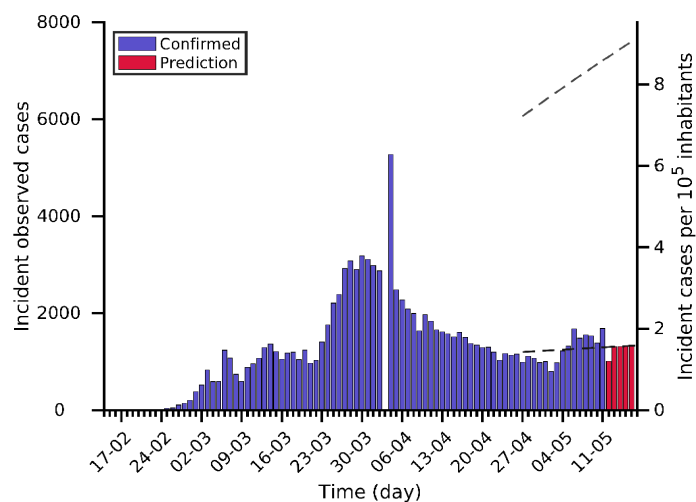
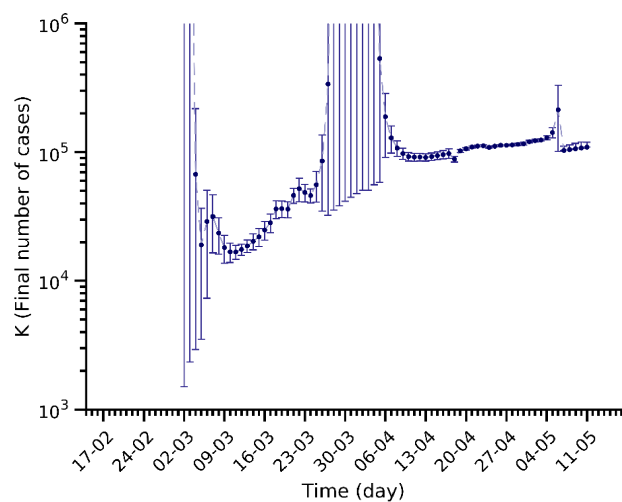
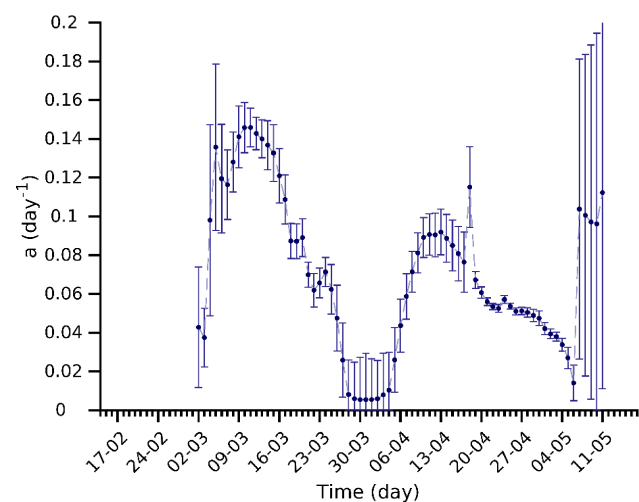
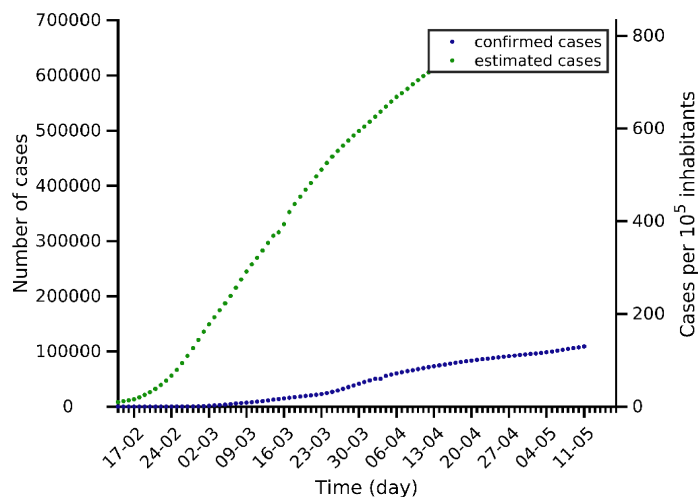
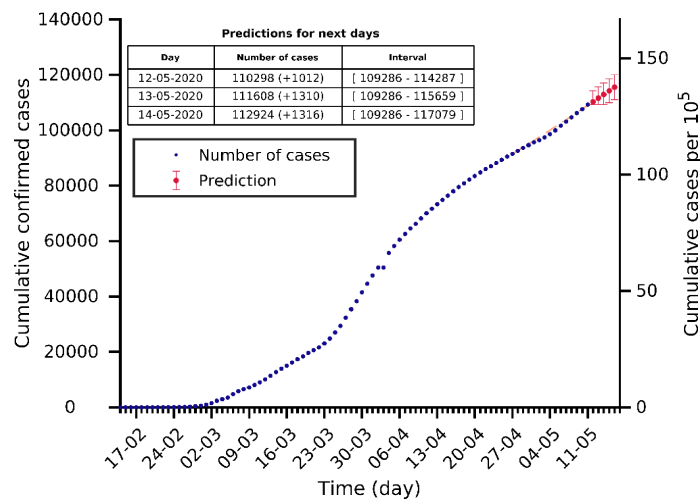
Turkey 11-05-2020. Population: 84.3M. Current cumulated incidence: 166/10⁵



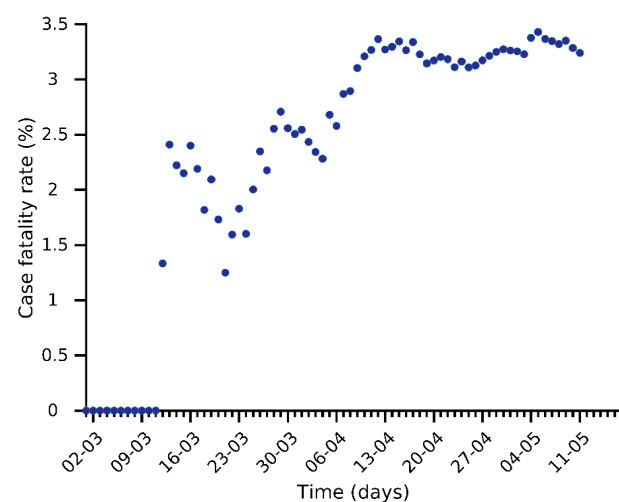
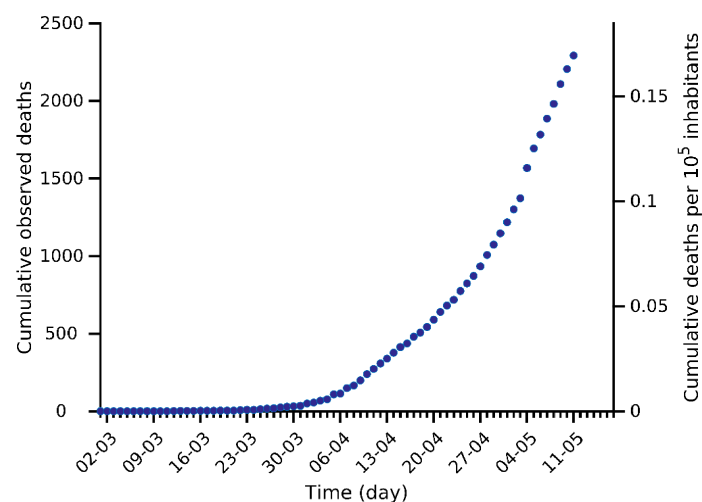
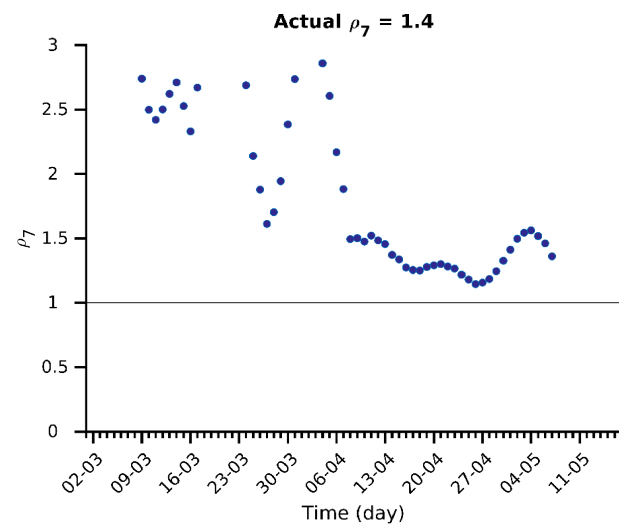
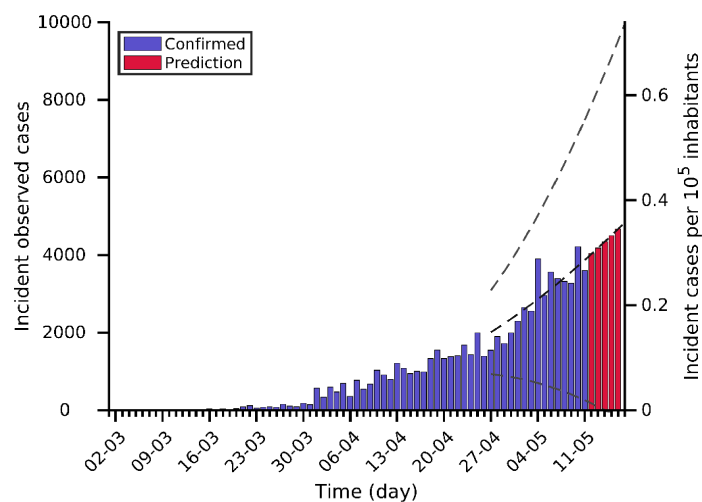
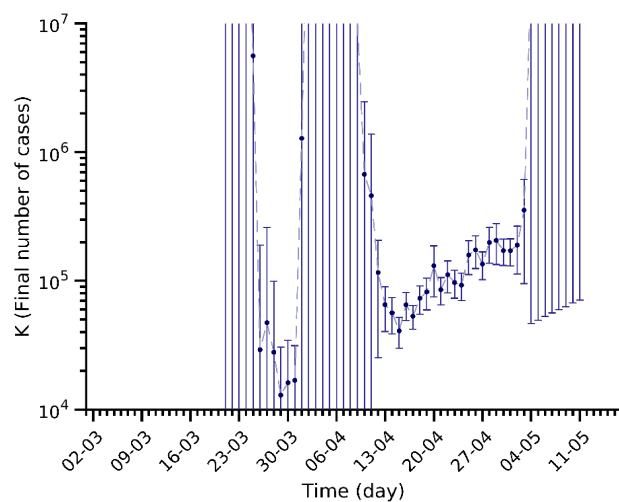
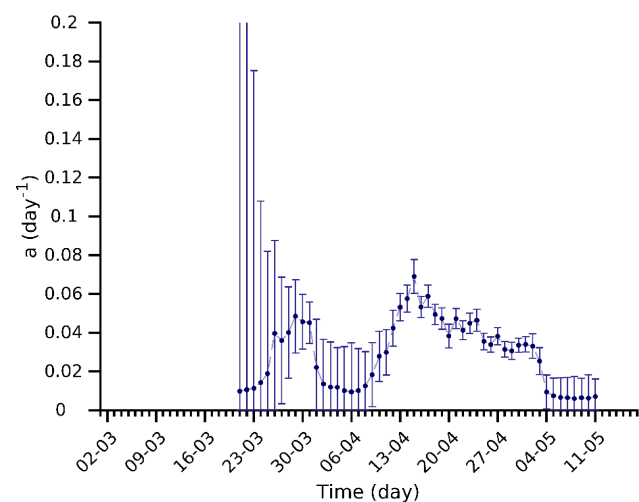
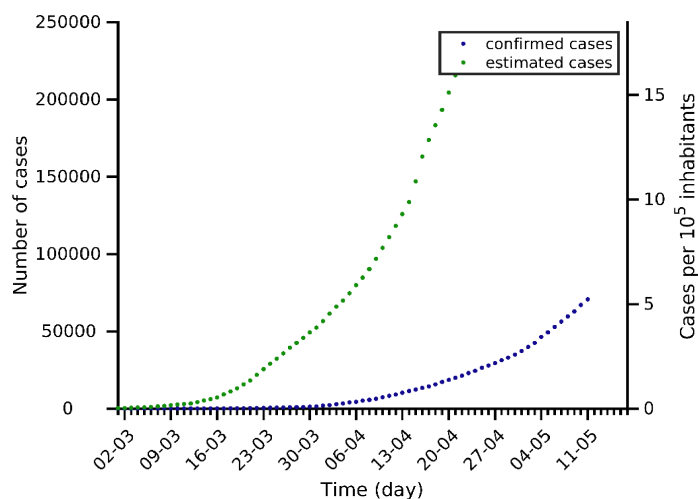
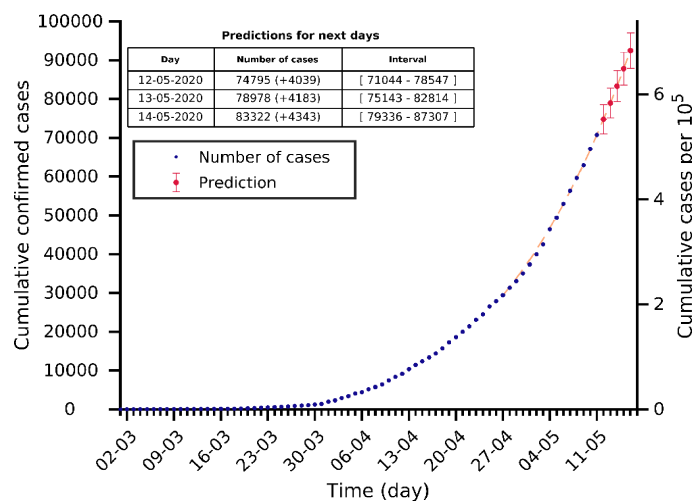
USA 11-05-2020. Population: 331.0M. Current cumulated incidence: 407/10⁵



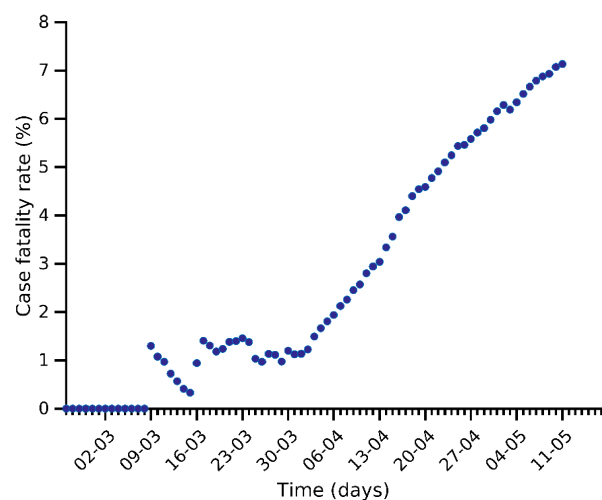
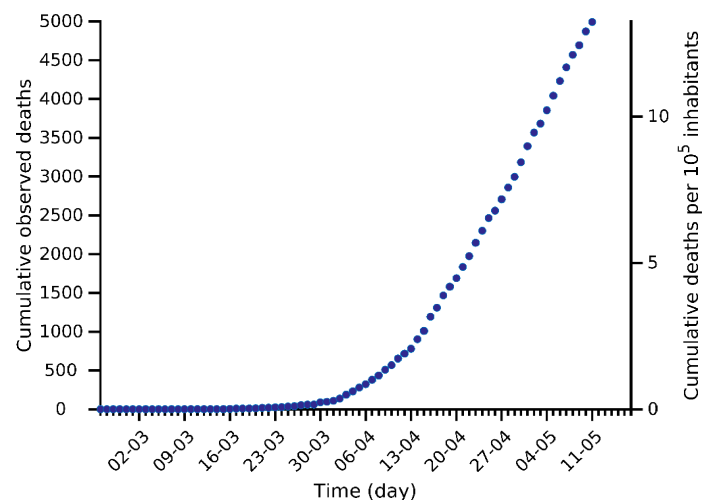
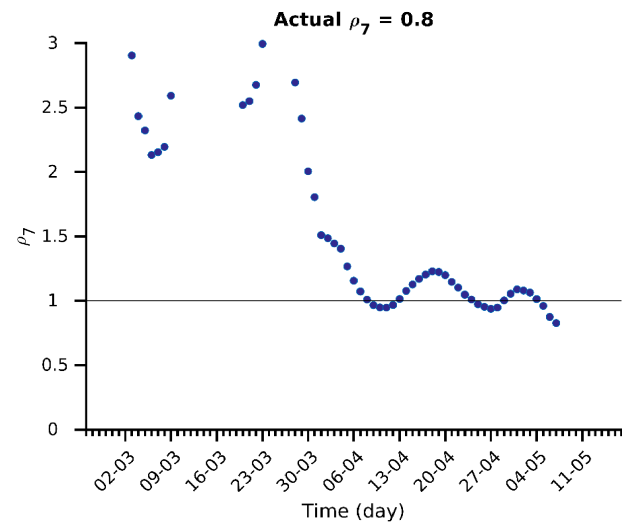
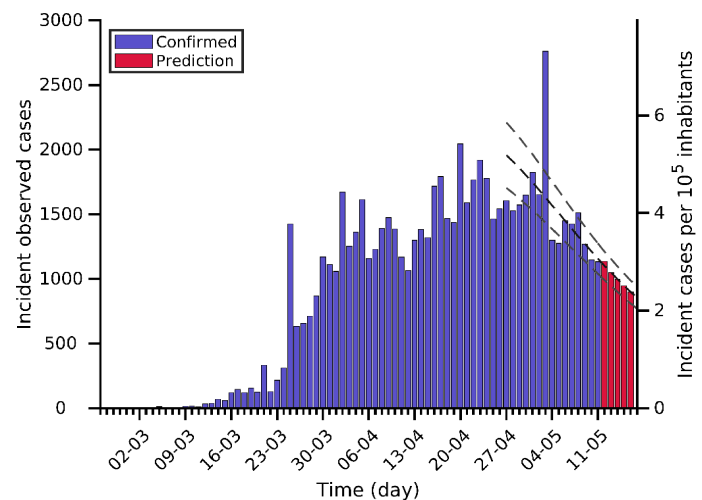
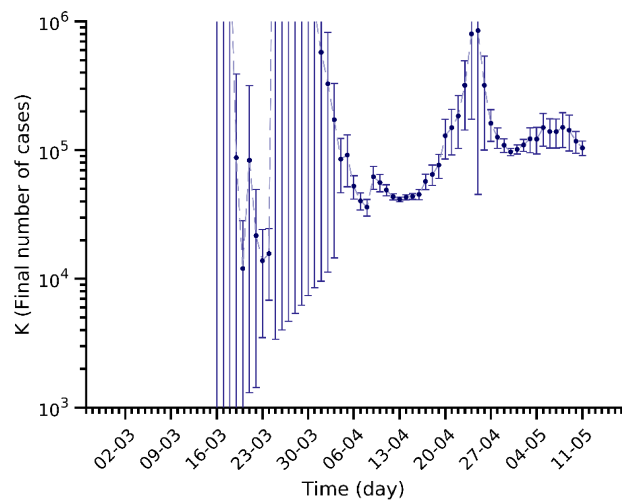
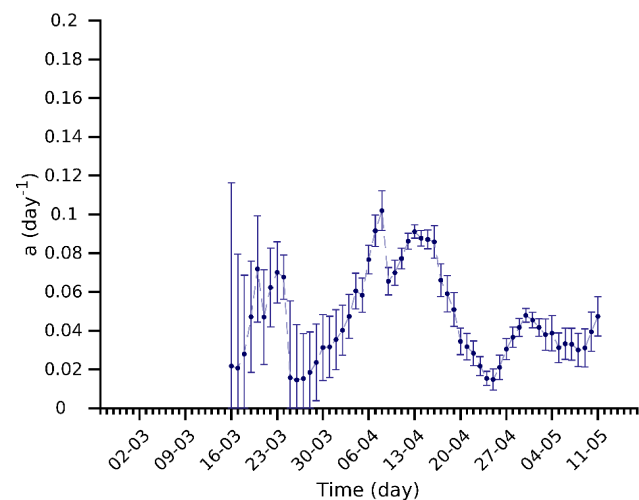
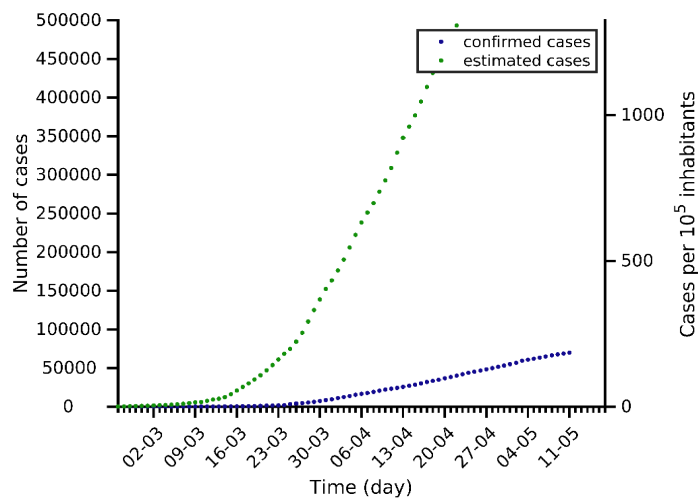
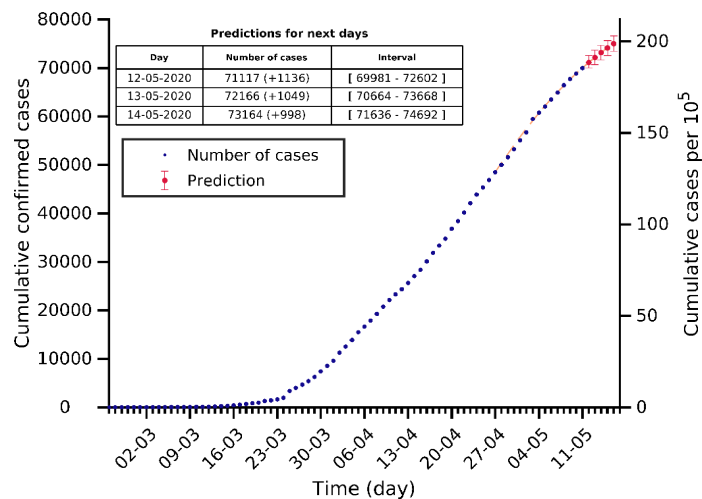
Iran 11-05-2020. Population: 84.0M. Current cumulated incidence: 130/10⁵



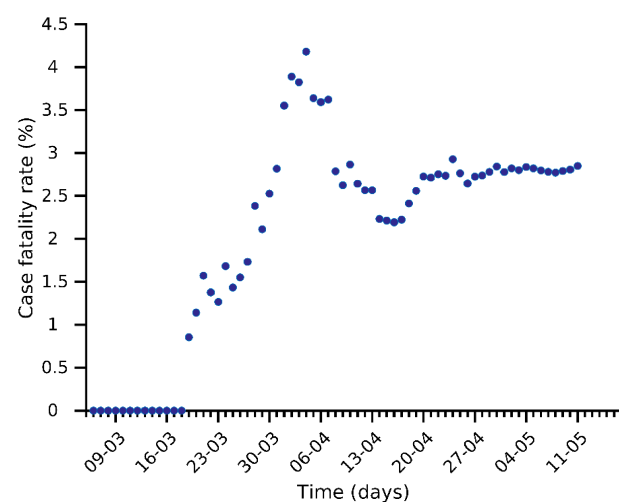
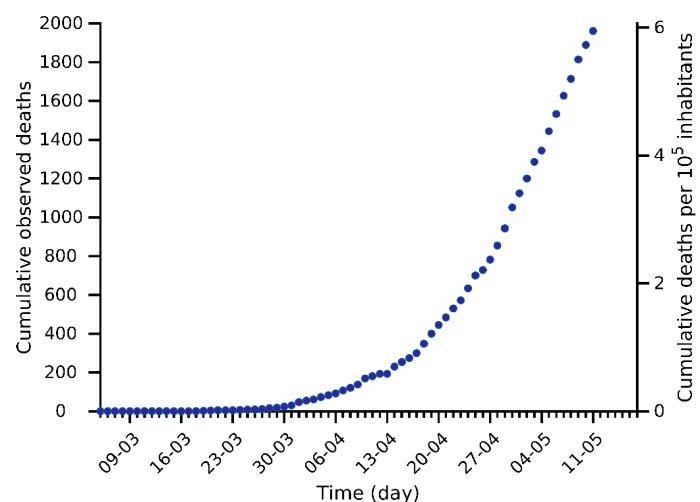
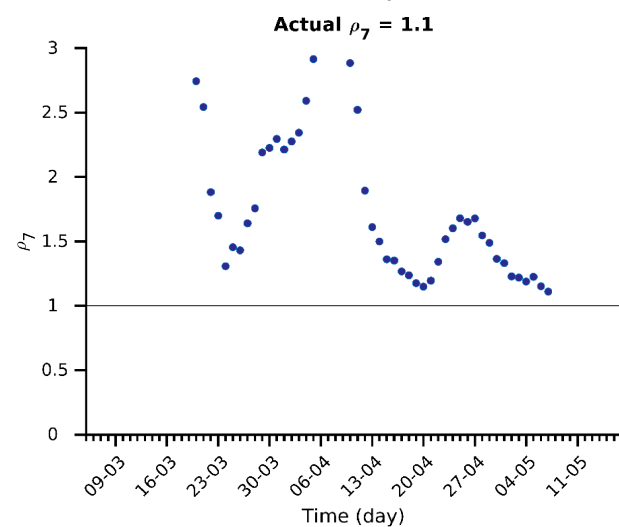
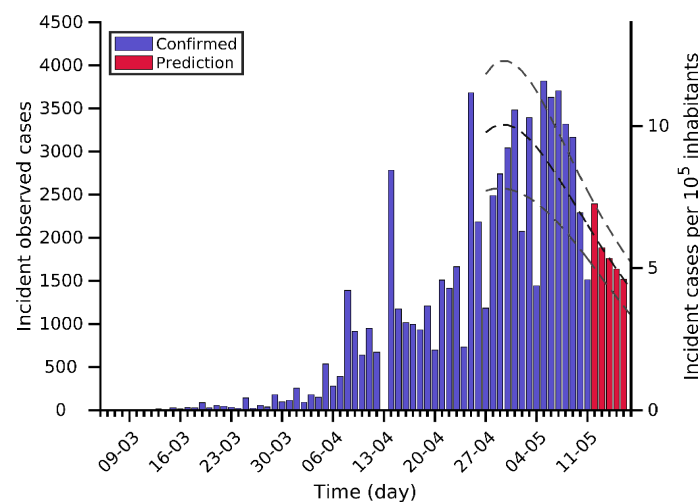
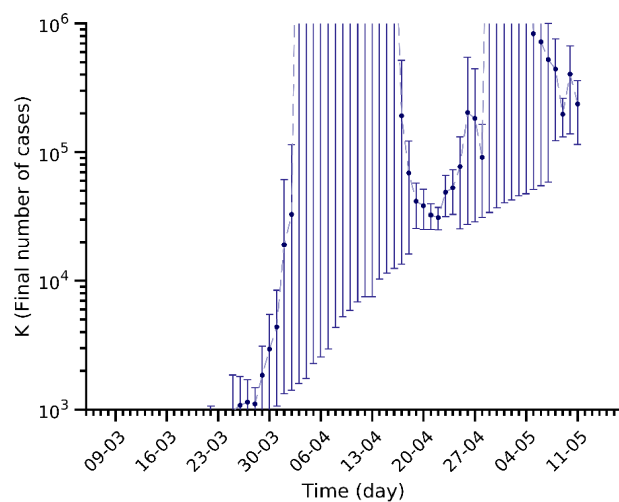
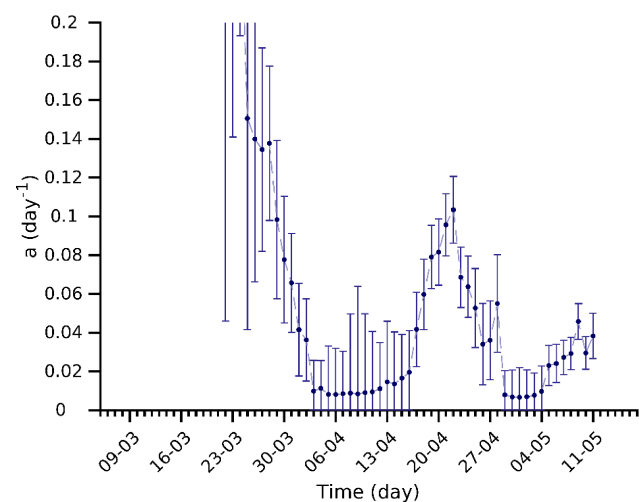
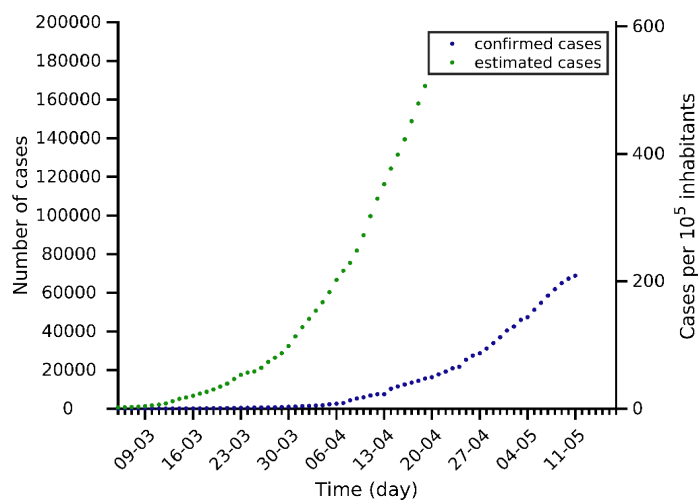
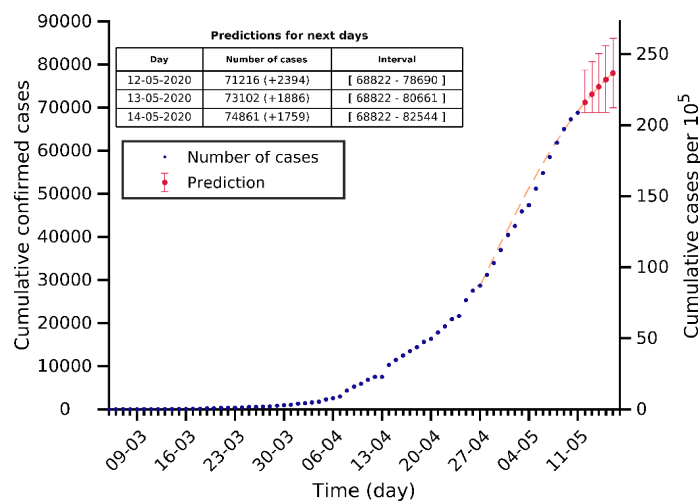
India 11-05-2020. Population: 1353.0M. Current cumulated incidence: 5/10⁵



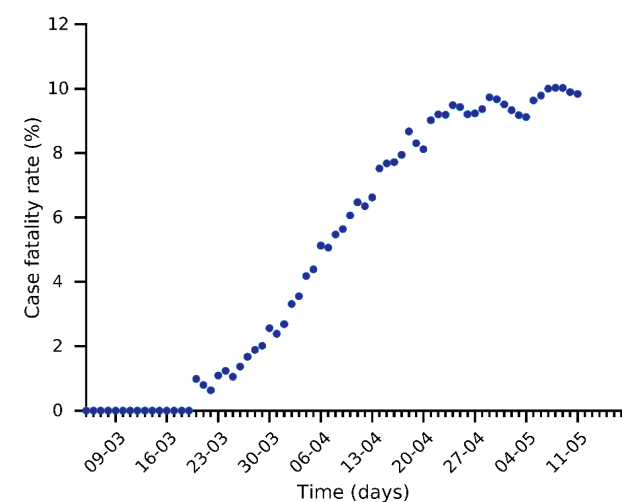
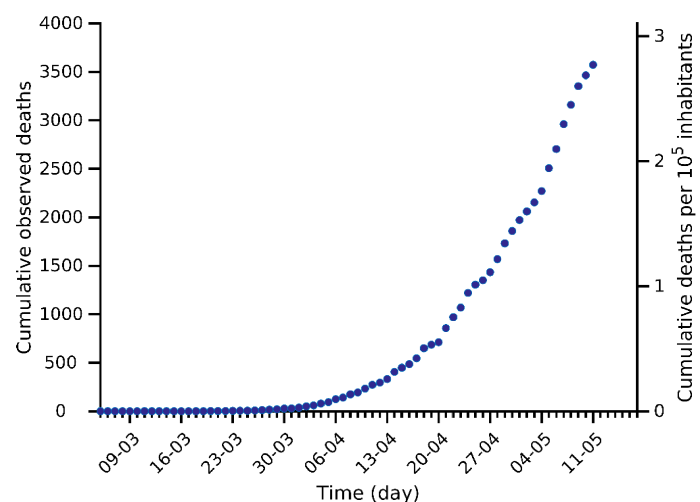
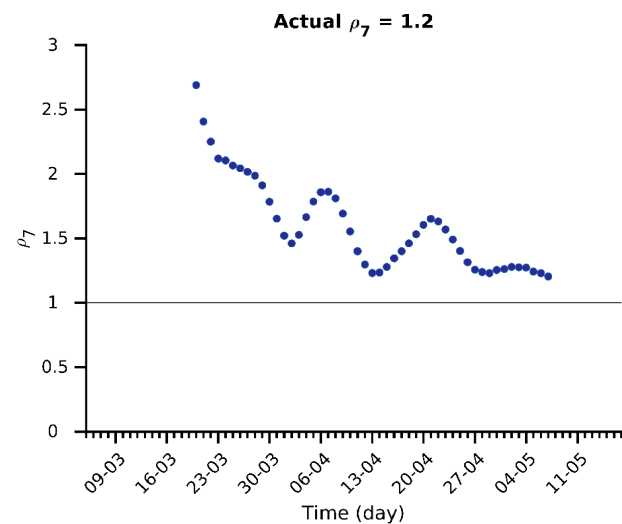
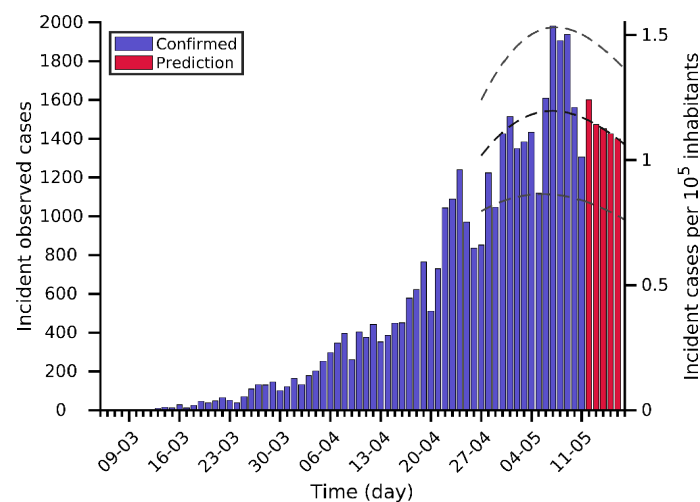
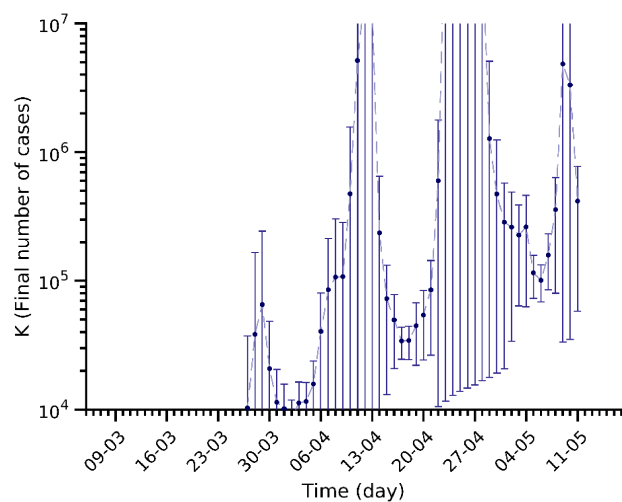
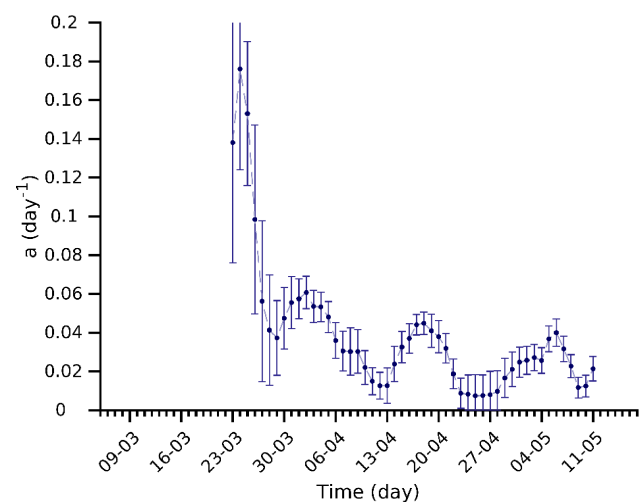
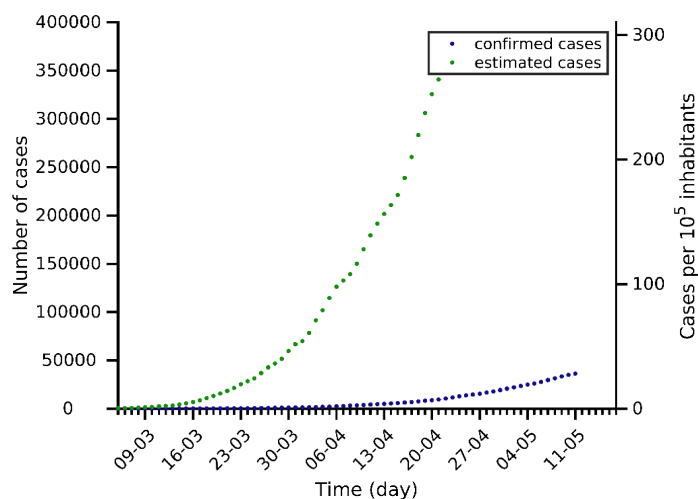
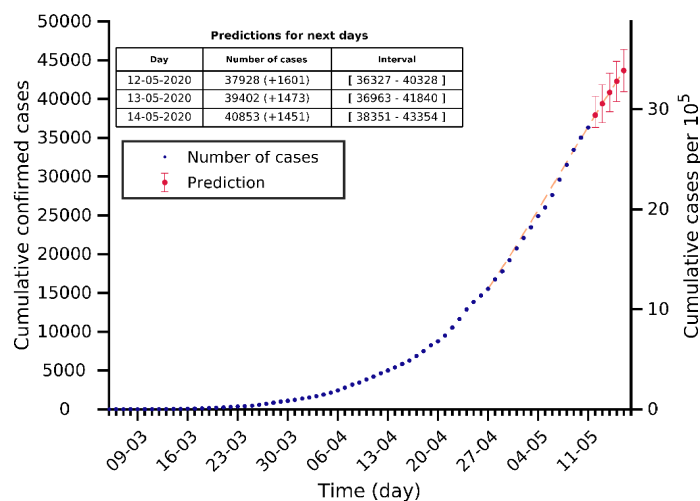
Canada 11-05-2020. Population: 37.7M. Current cumulated incidence: 185/10⁵



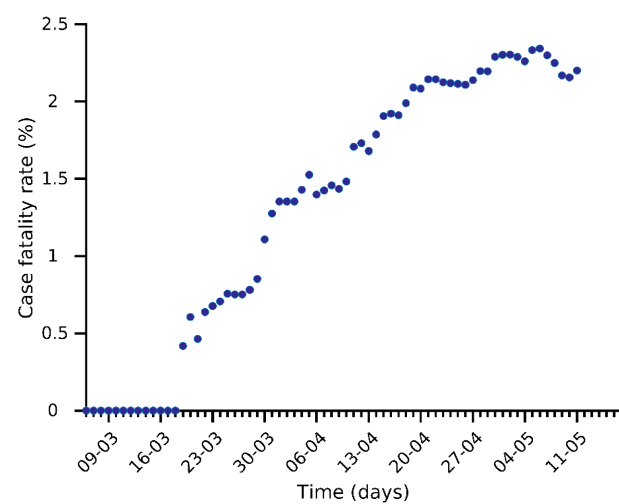
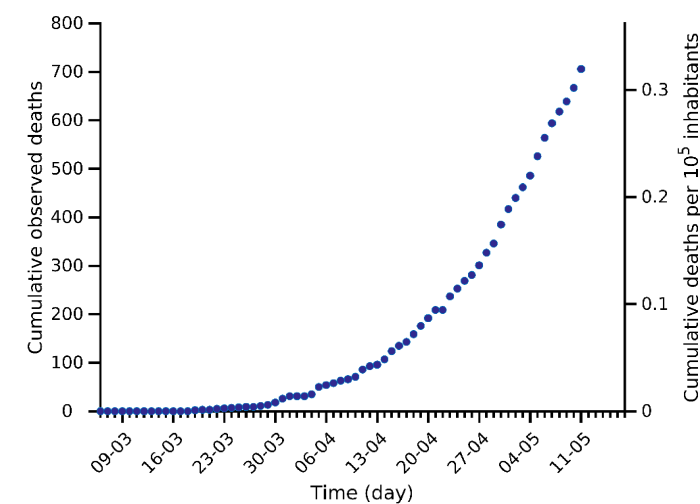
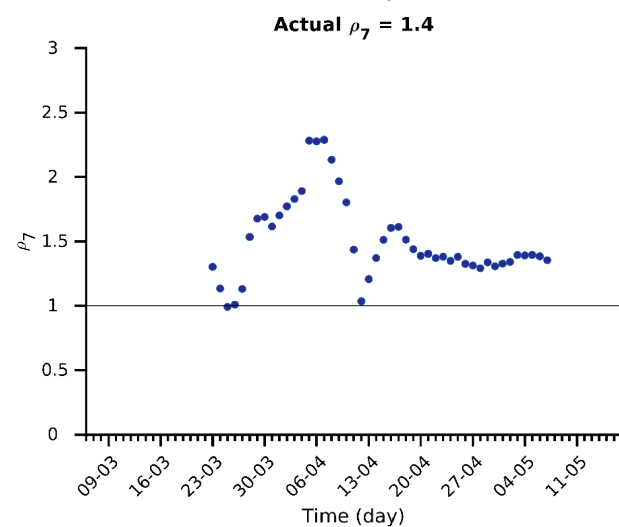
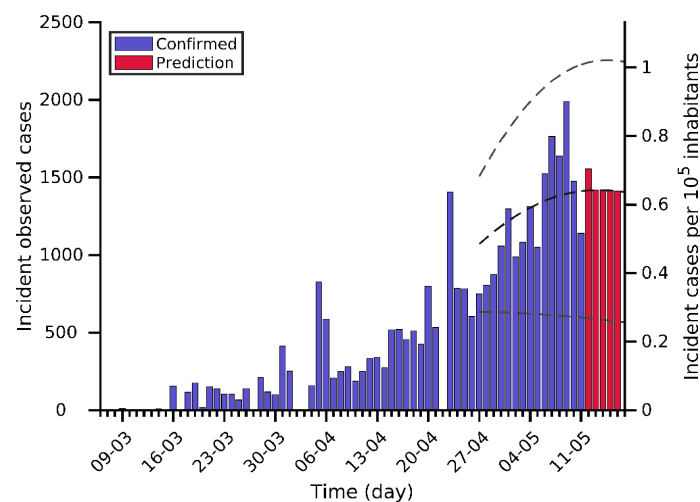
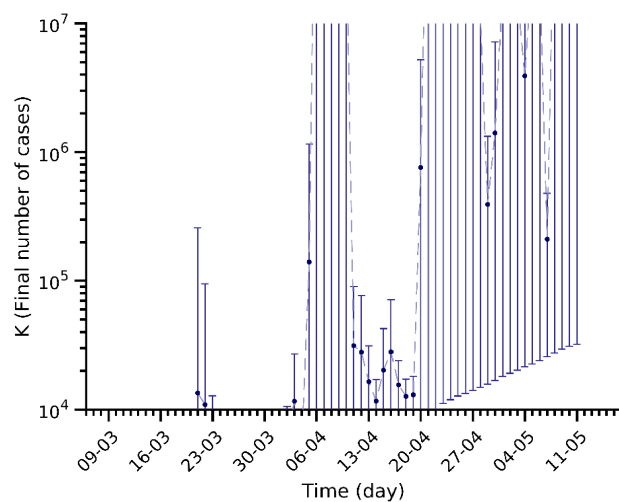
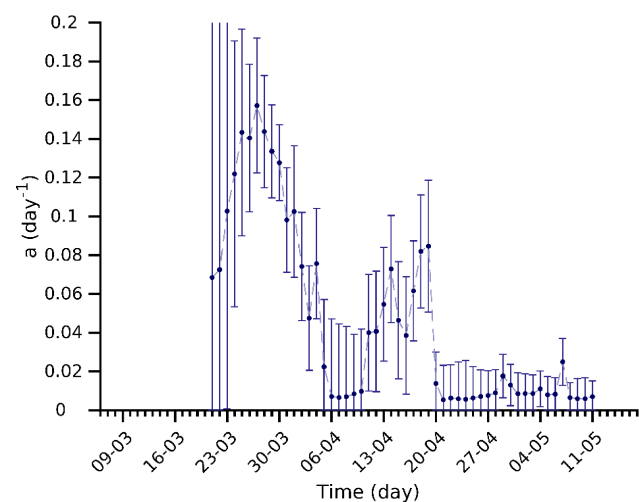
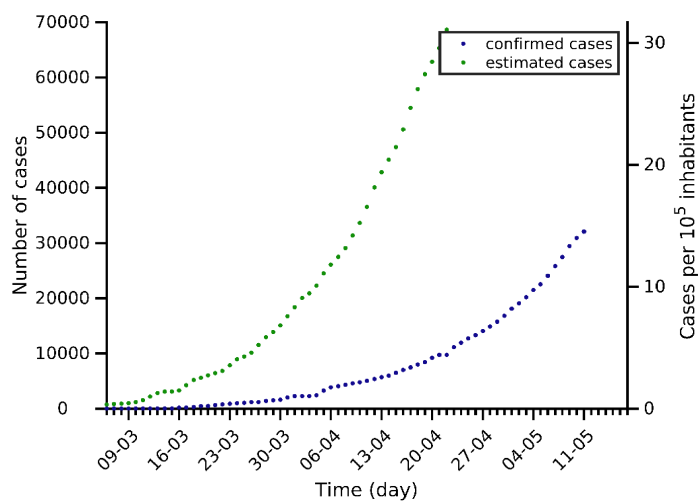
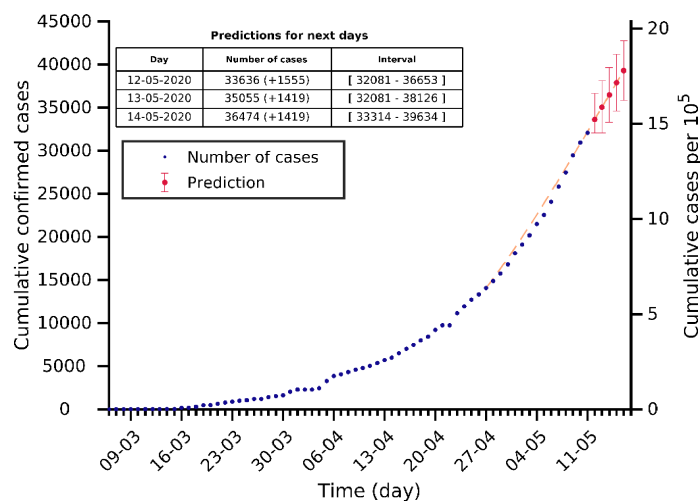
Peru 11-05-2020. Population: 33.0M. Current cumulated incidence: 209/10⁵



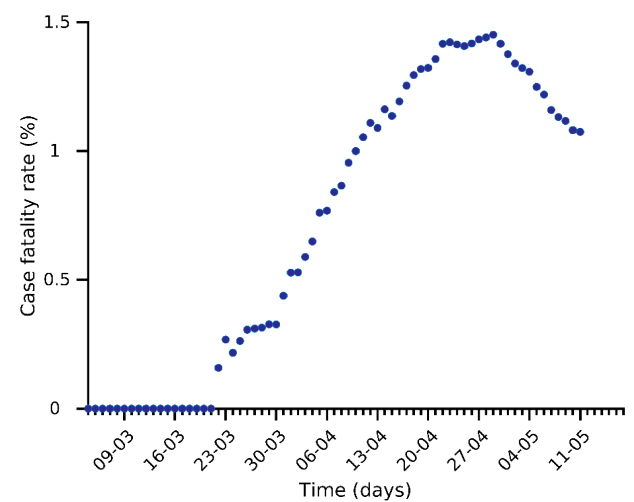
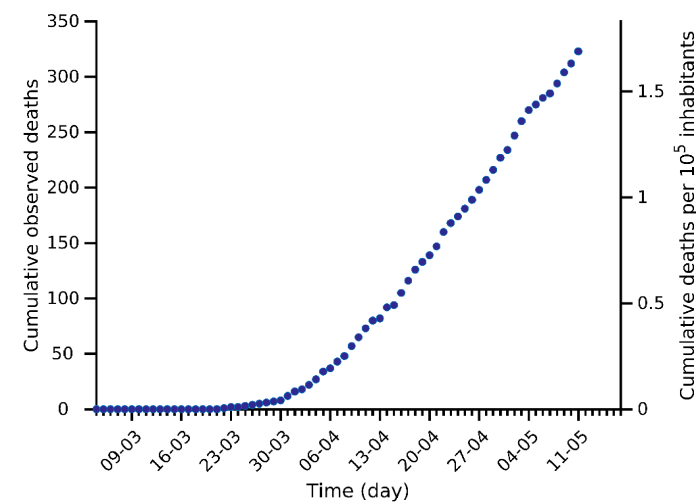
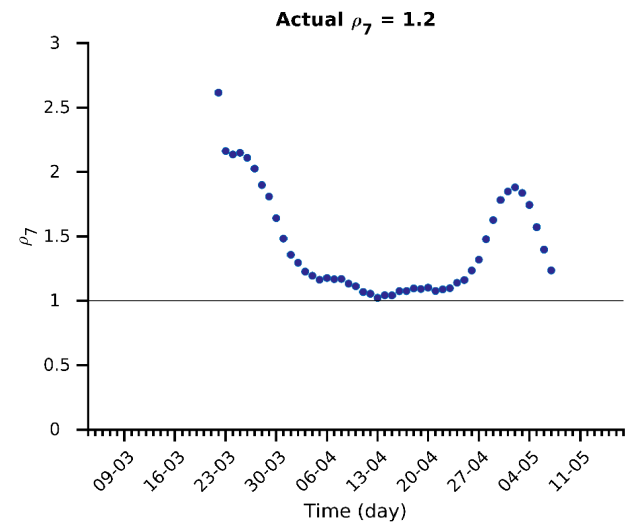
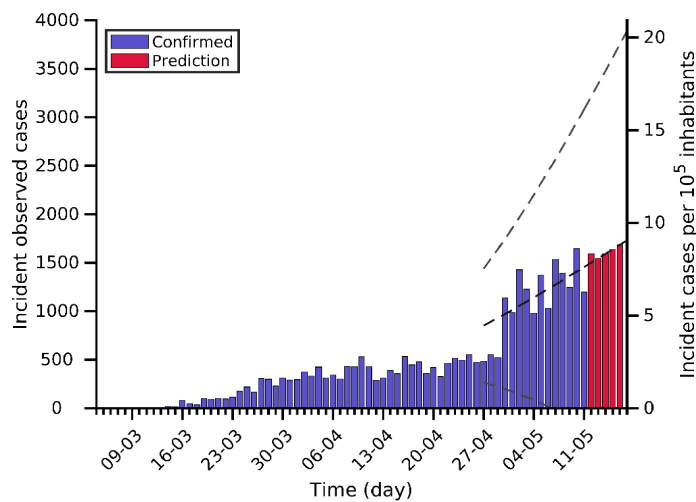
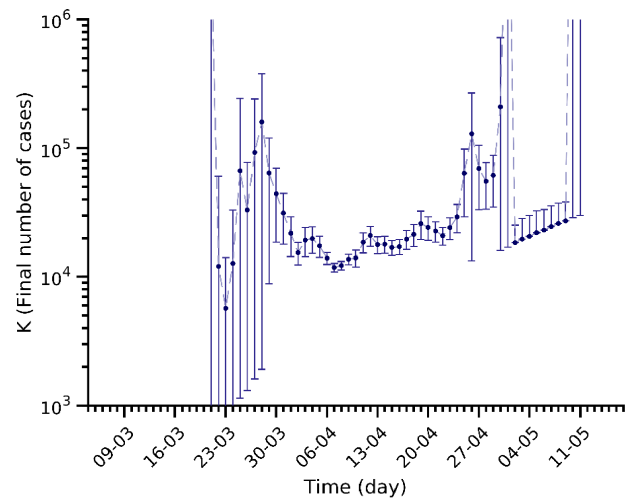
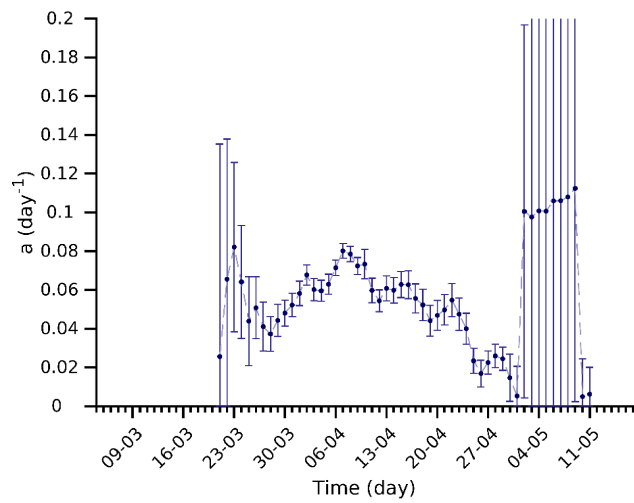
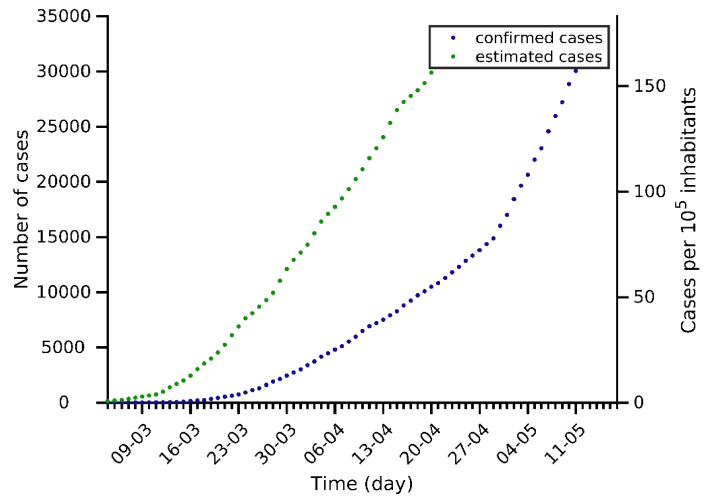
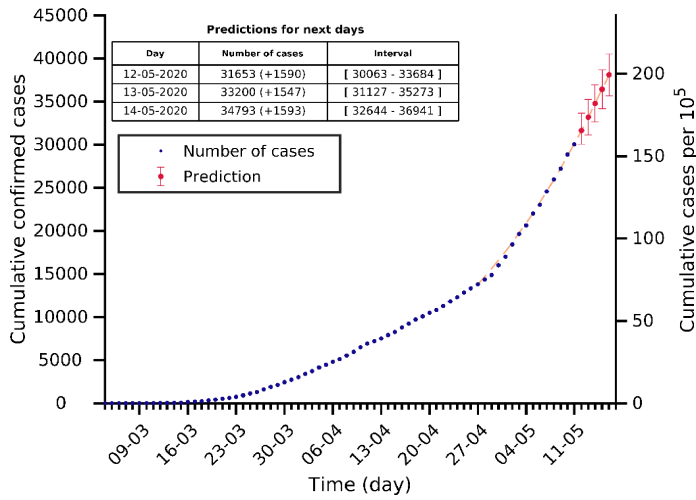
Mexico 11-05-2020. Population: 128.9M. Current cumulated incidence: 28/10⁵



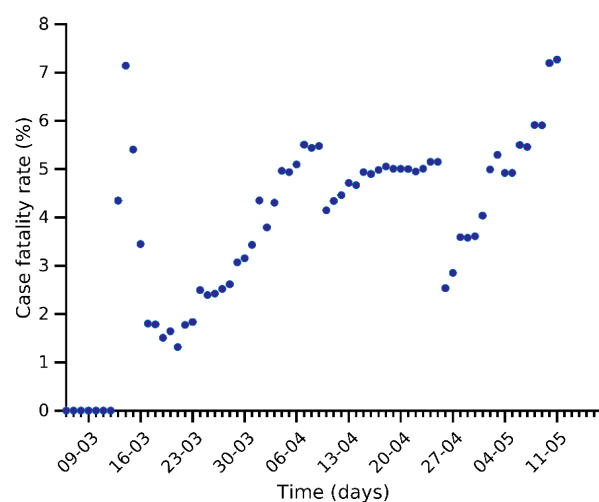
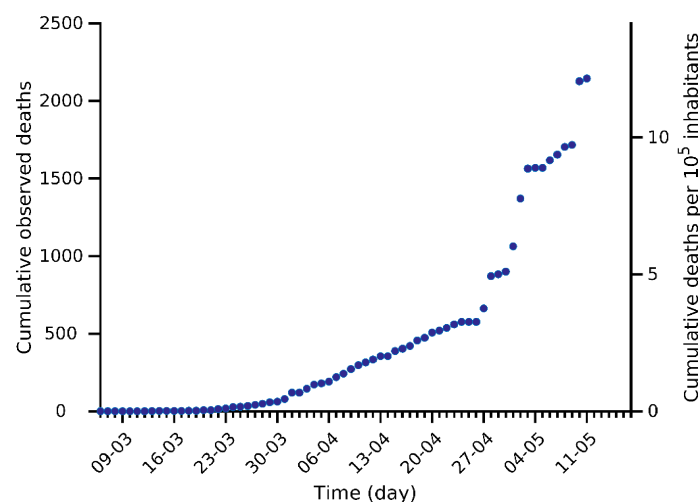
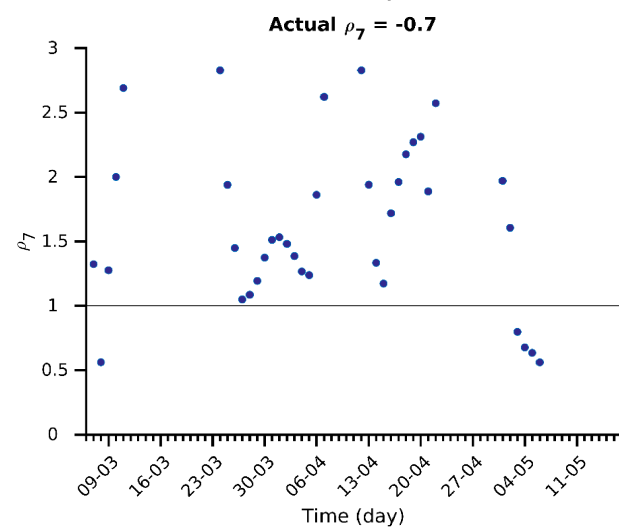
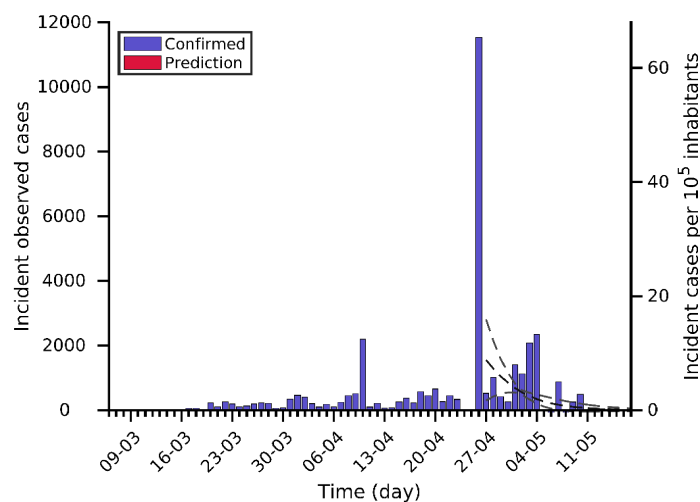
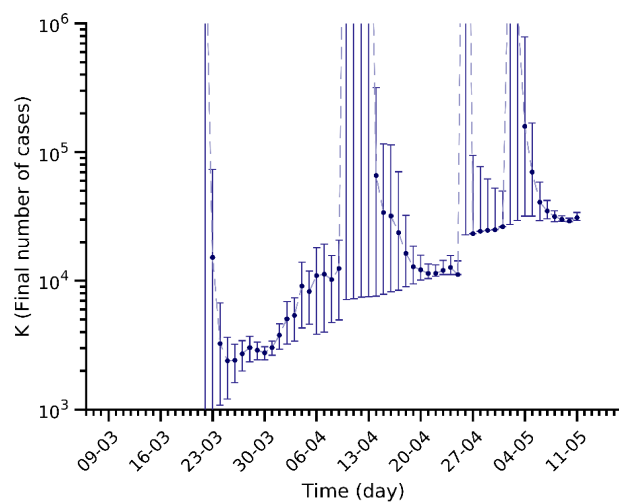
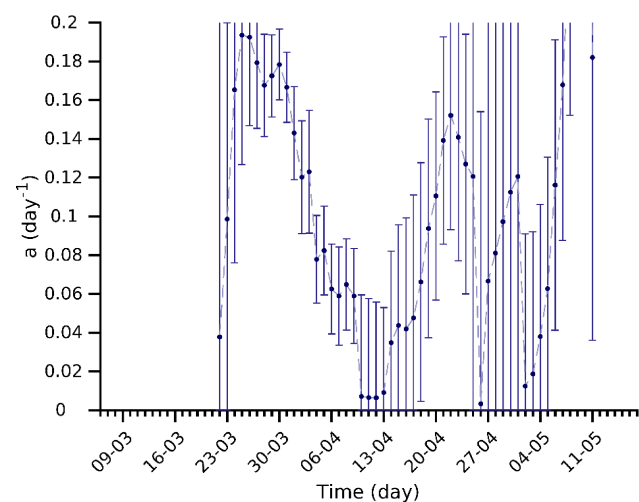
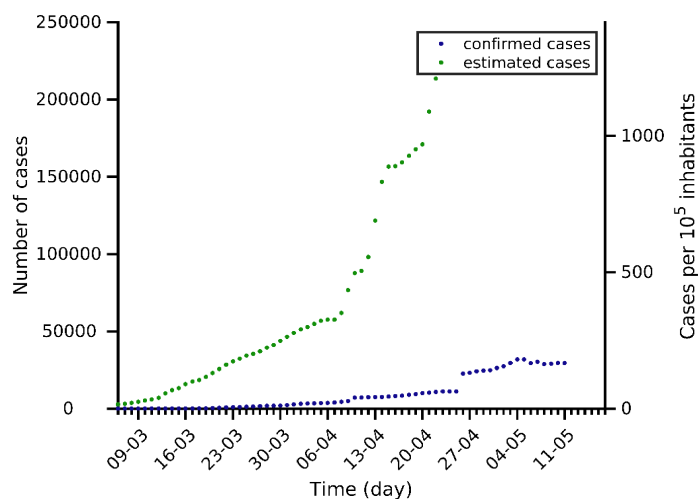
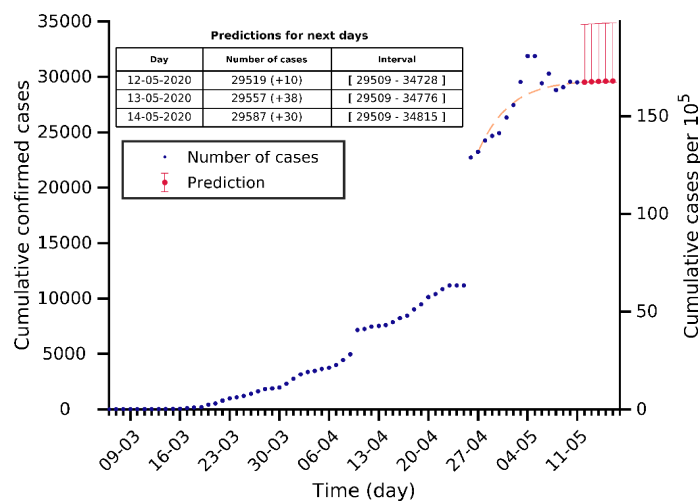
Pakistan 11-05-2020. Population: 220.9M. Current cumulated incidence: 15/10⁵



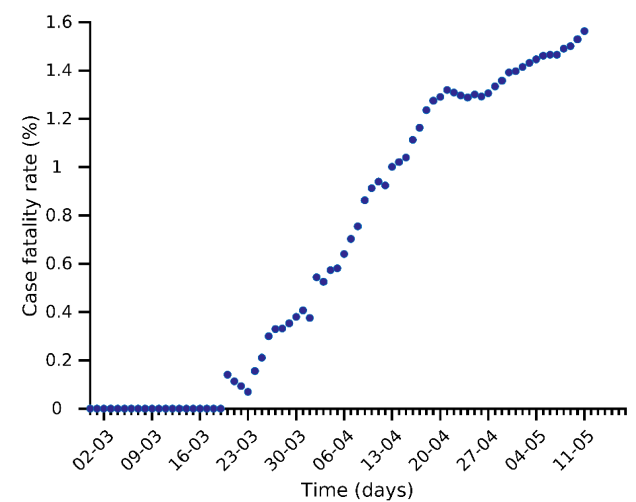
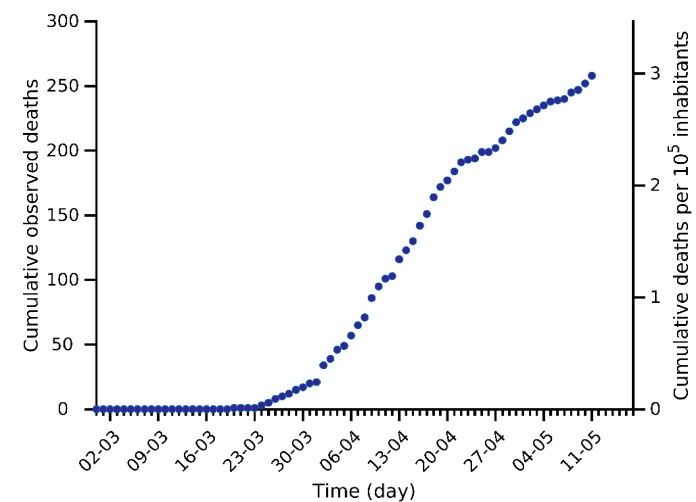
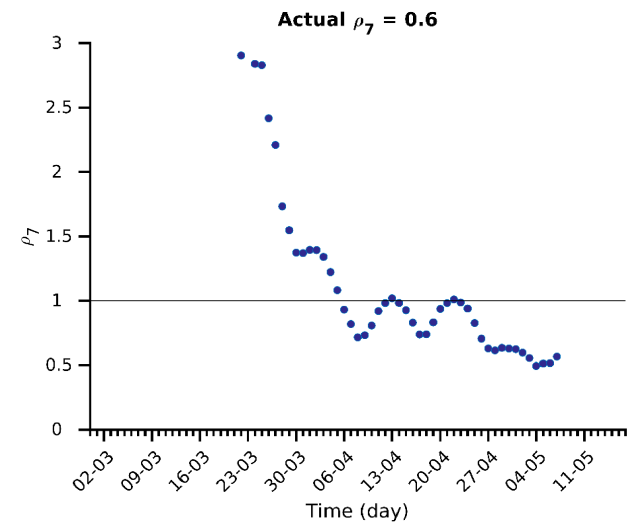
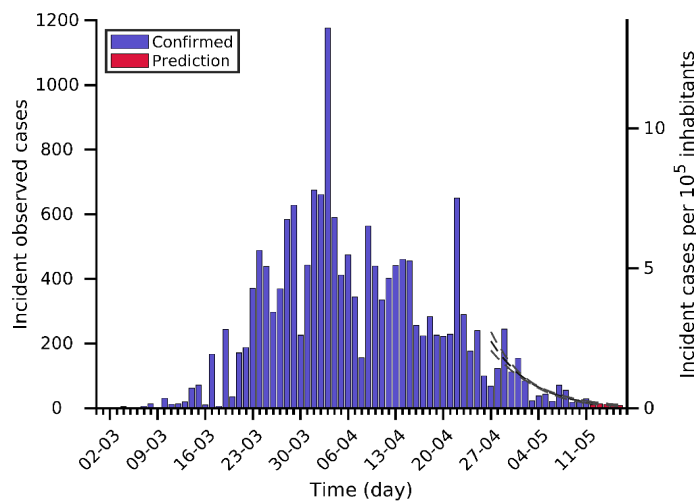
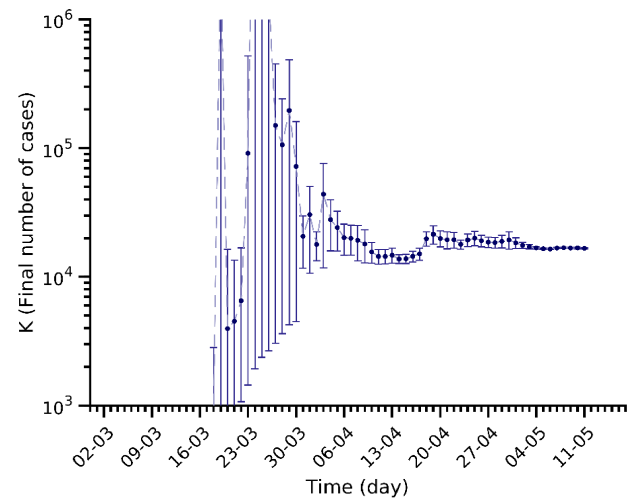
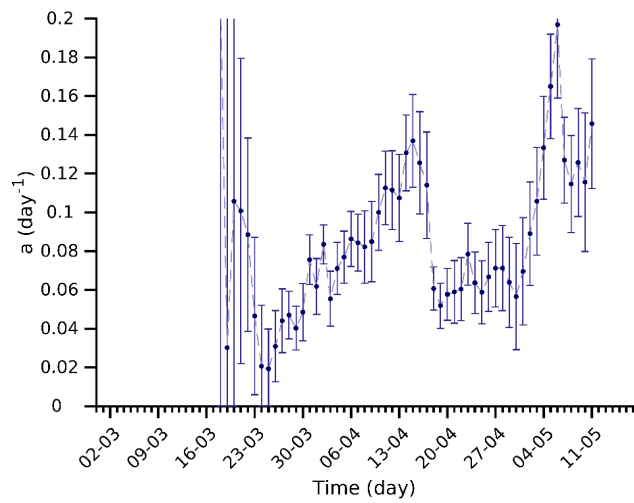
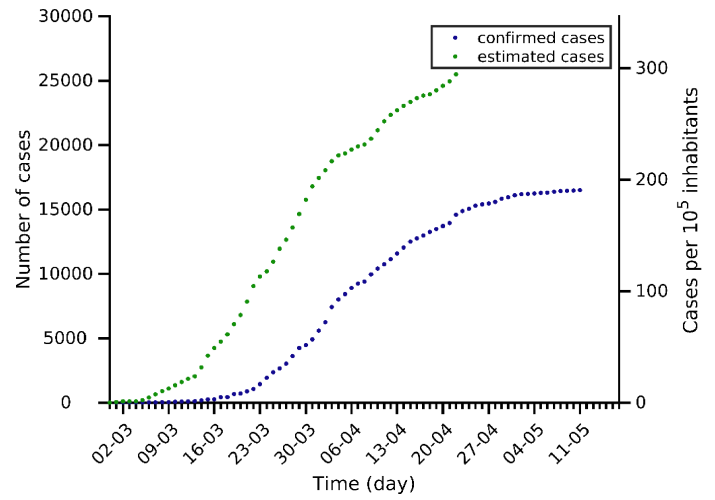
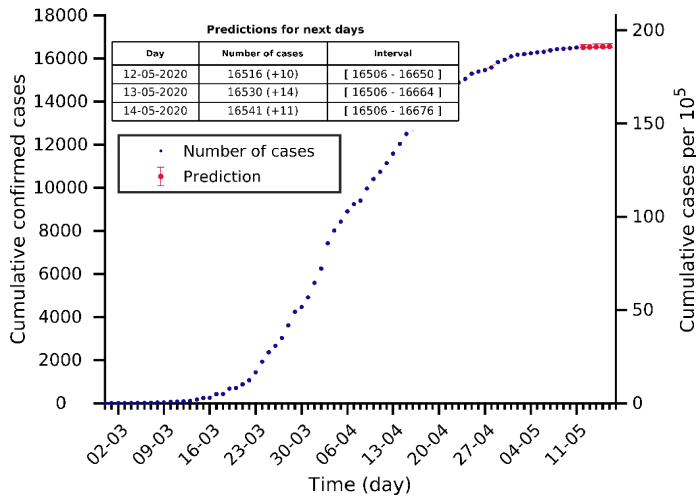
Chile 11-05-2020. Population: 19.1M. Current cumulated incidence: 157/10⁵



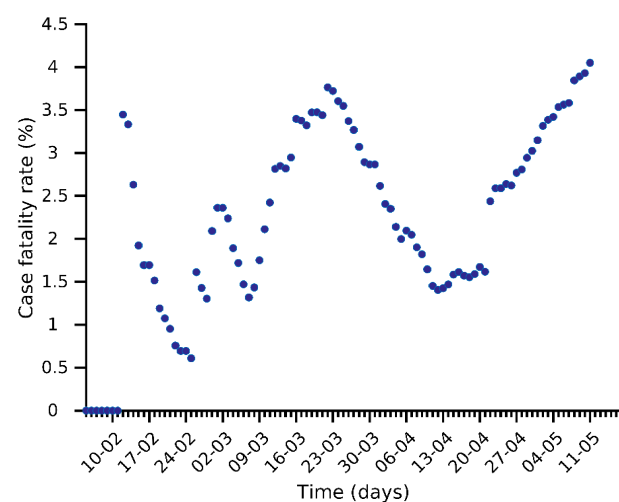
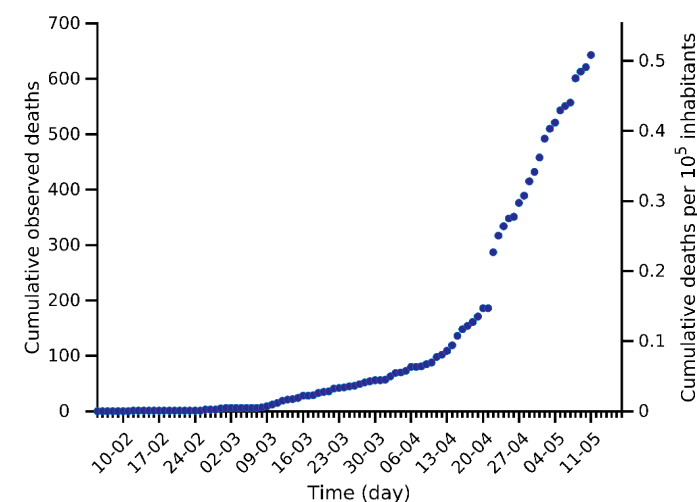
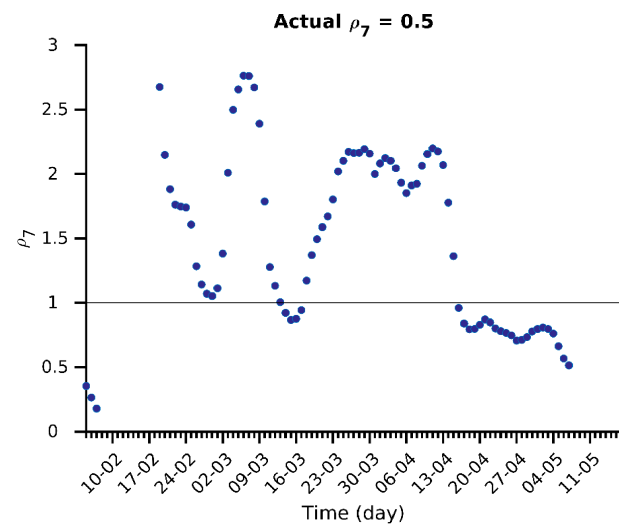
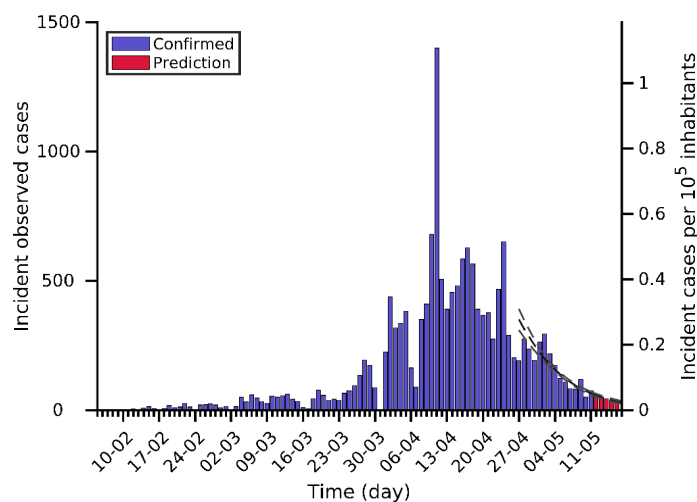
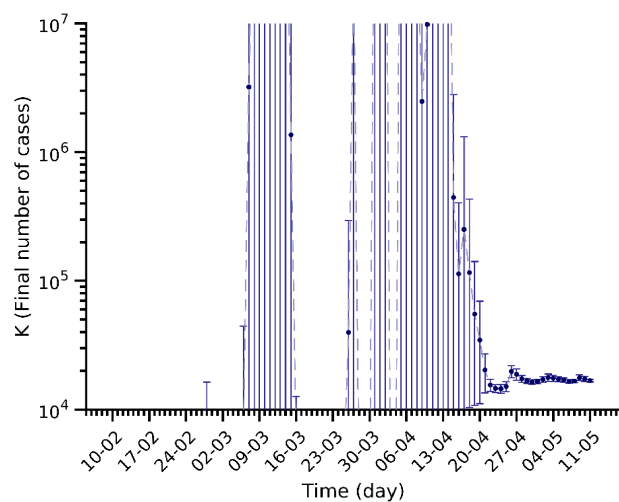
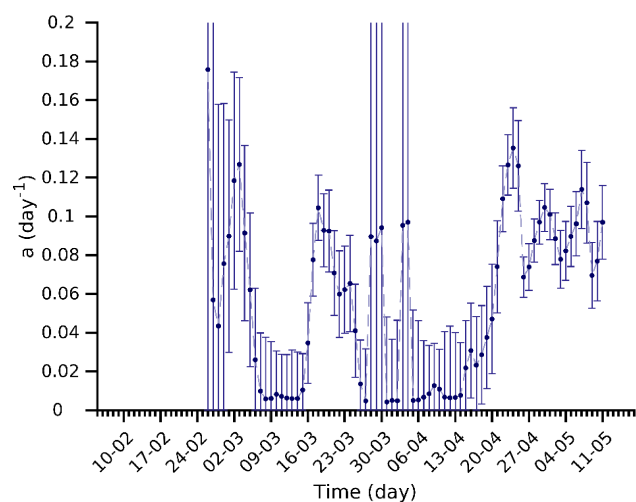
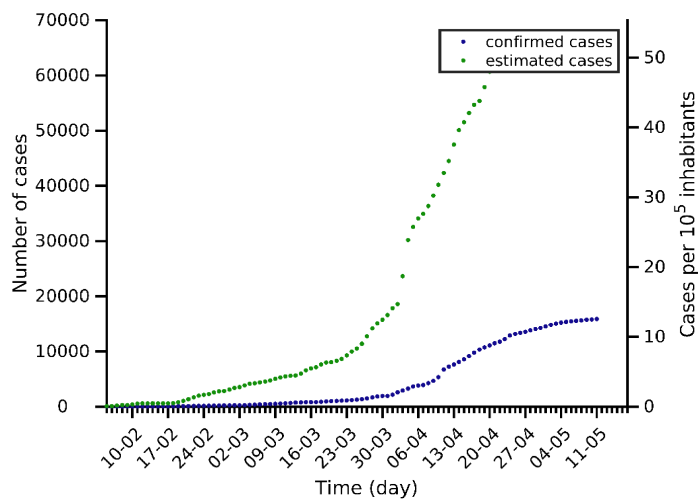
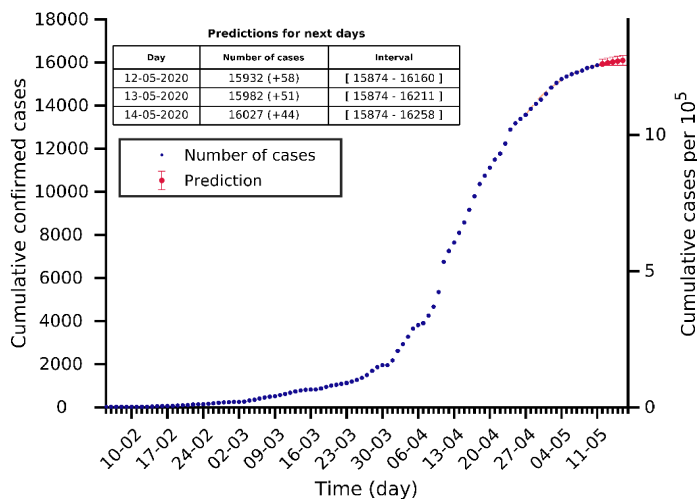
Ecuador 11-05-2020. Population: 17.6M. Current cumulated incidence: 167/10⁵



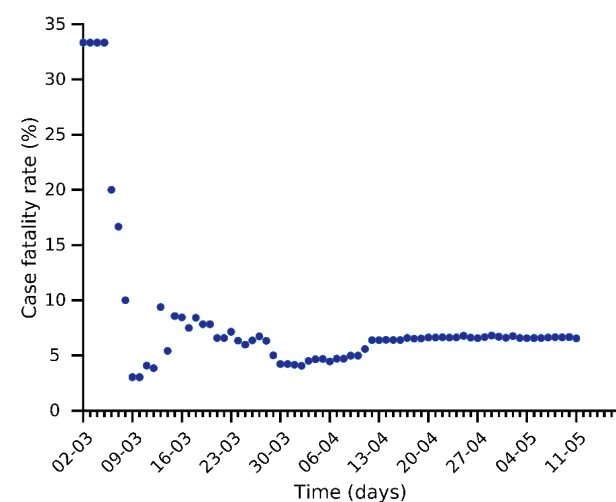
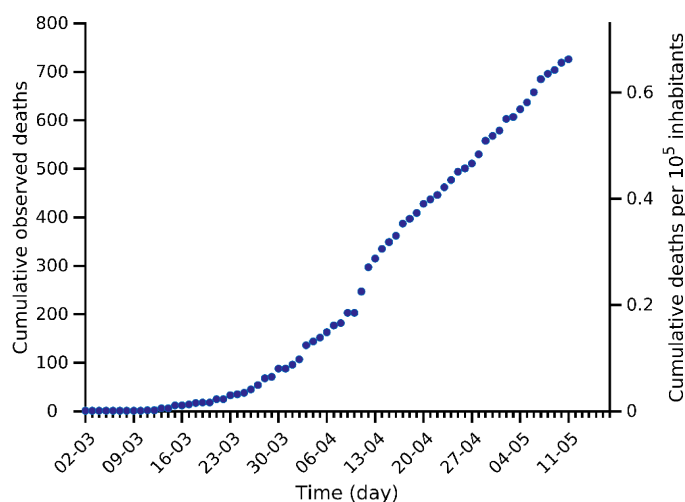
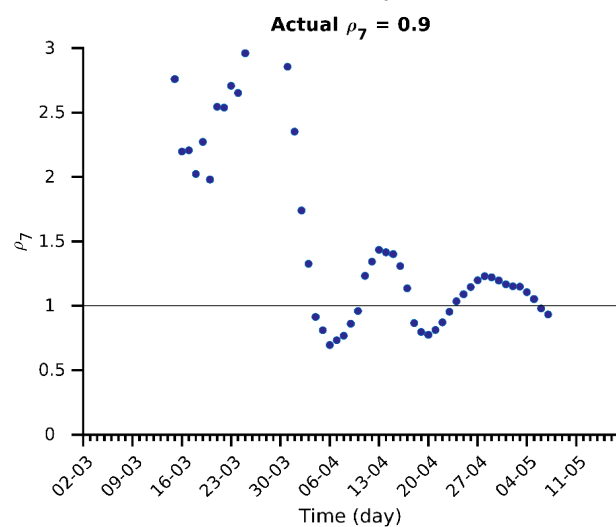
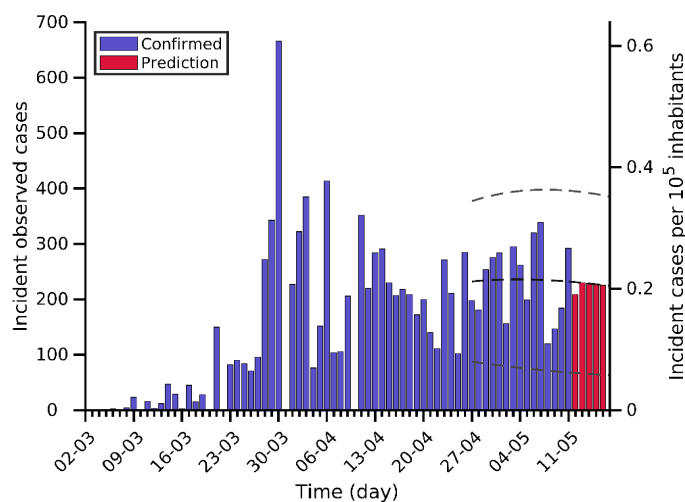
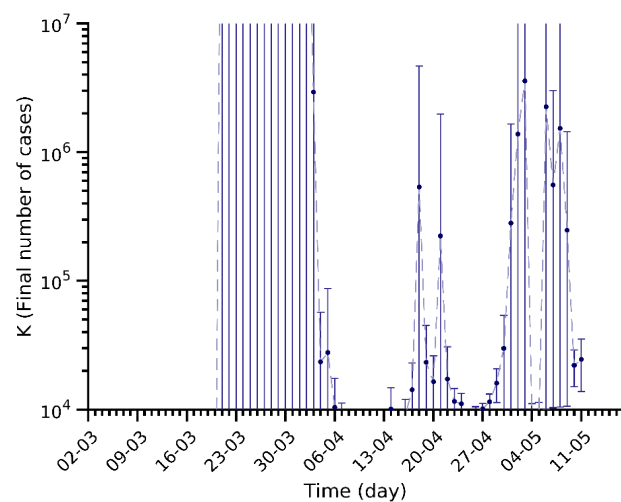
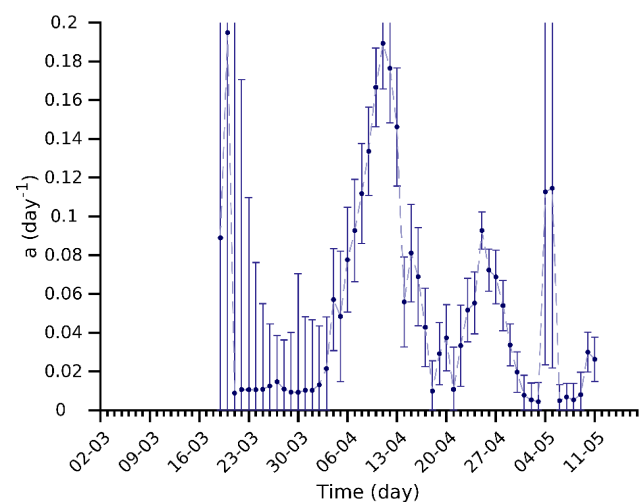
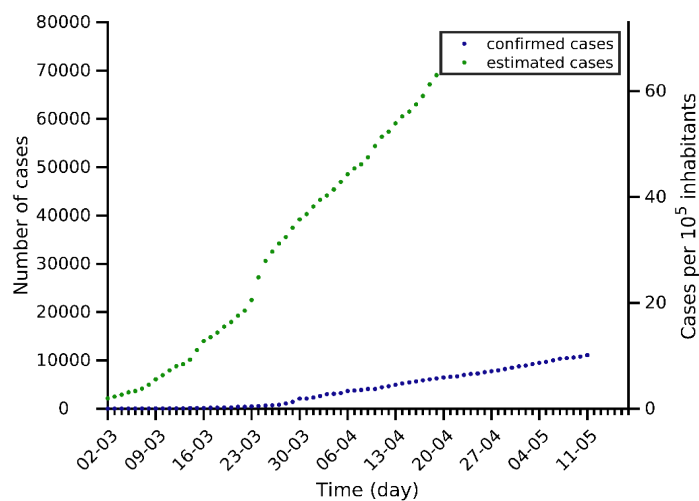
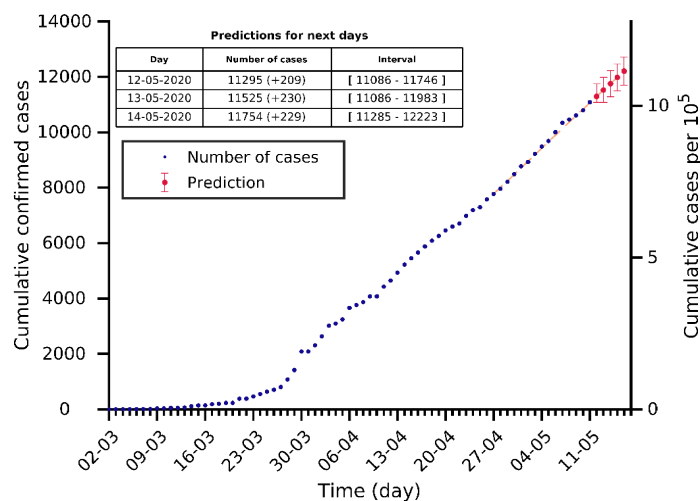
Israel 11-05-2020. Population: 8.7M. Current cumulated incidence: 191/10⁵



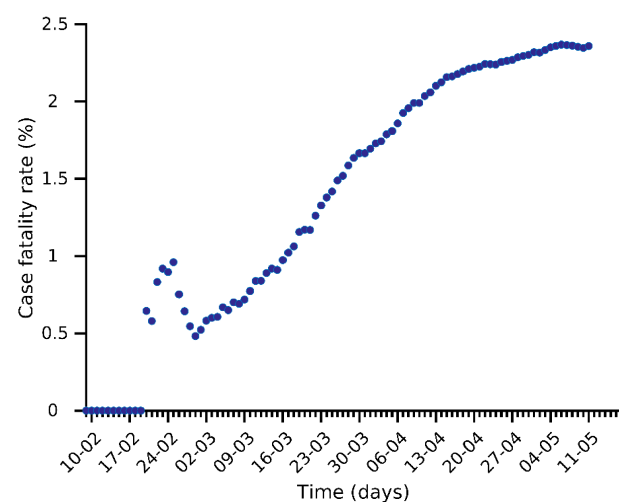
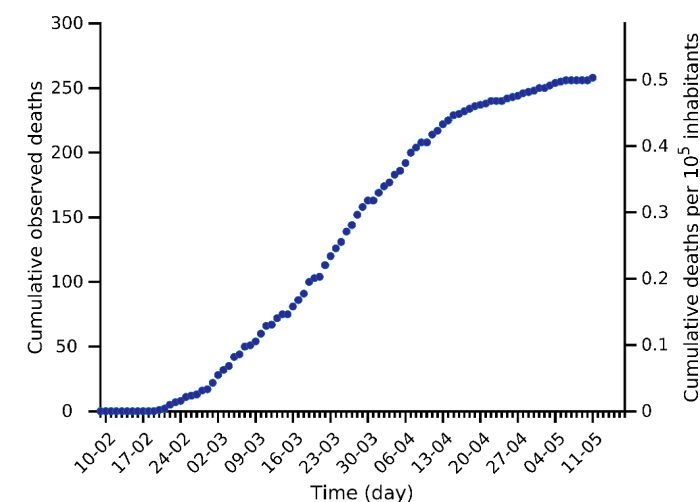
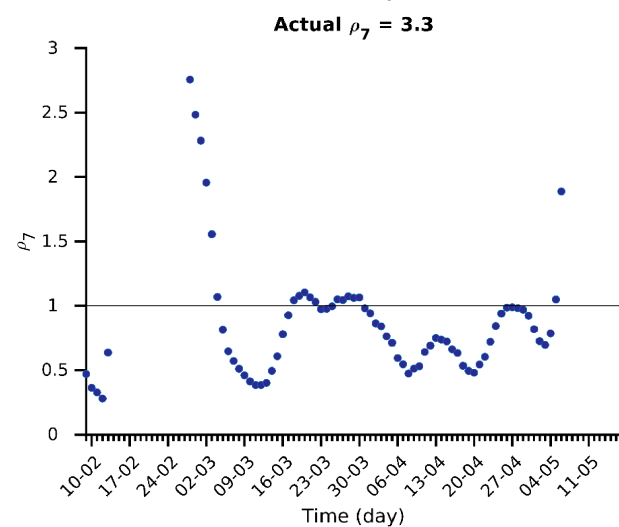
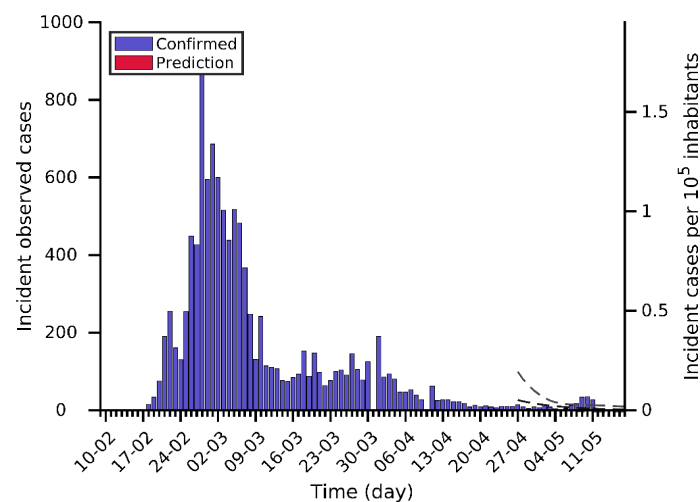
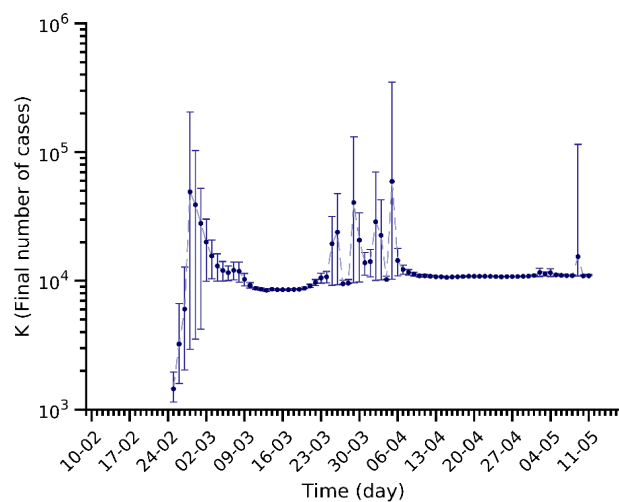
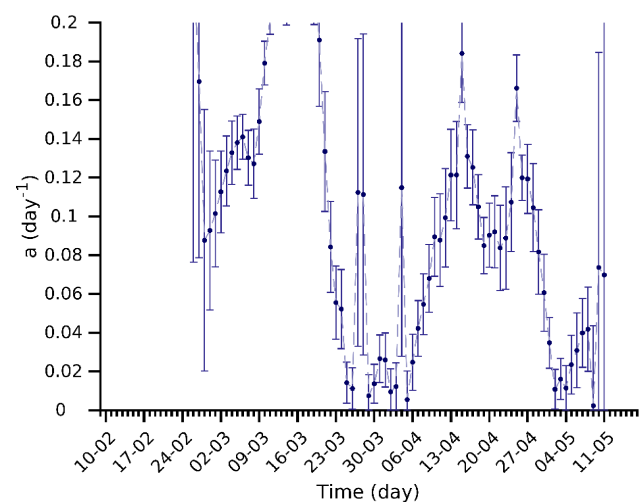
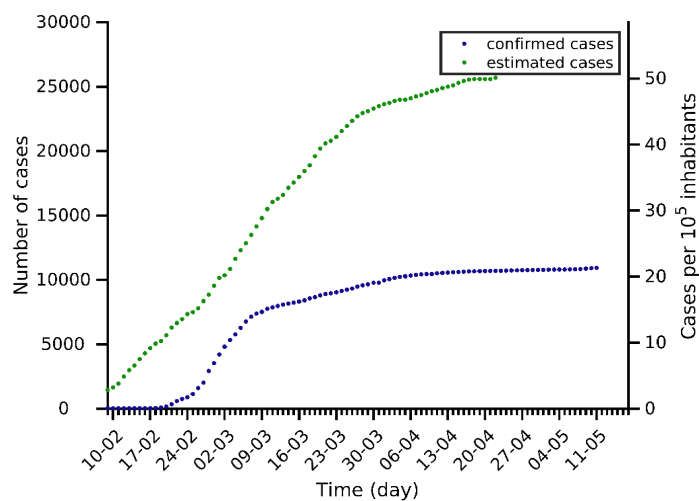
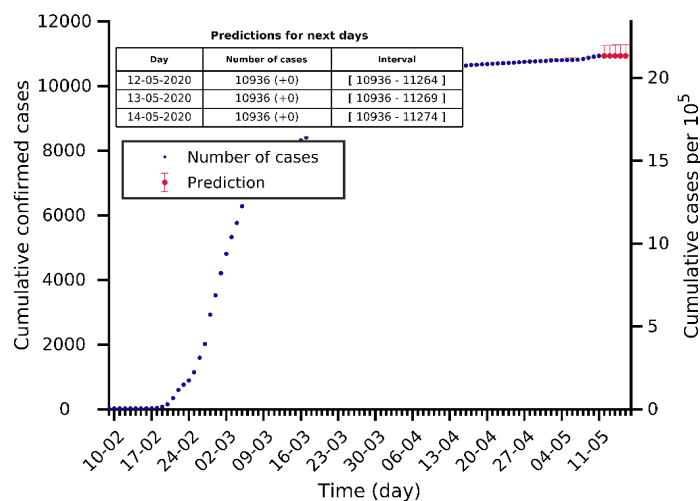
Japan 11-05-2020. Population: 126.5M. Current cumulated incidence: 13/10⁵



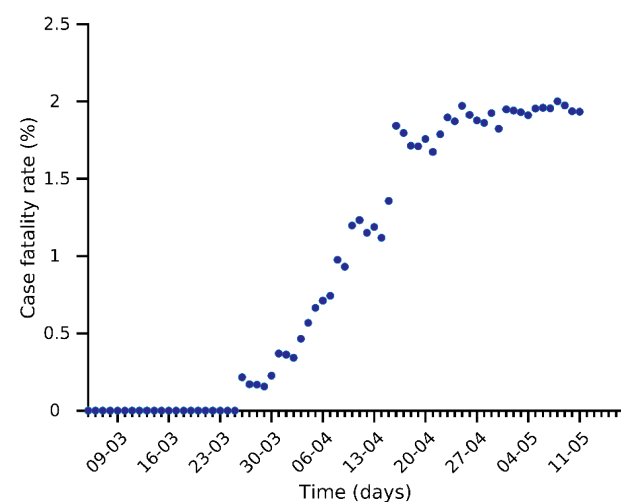
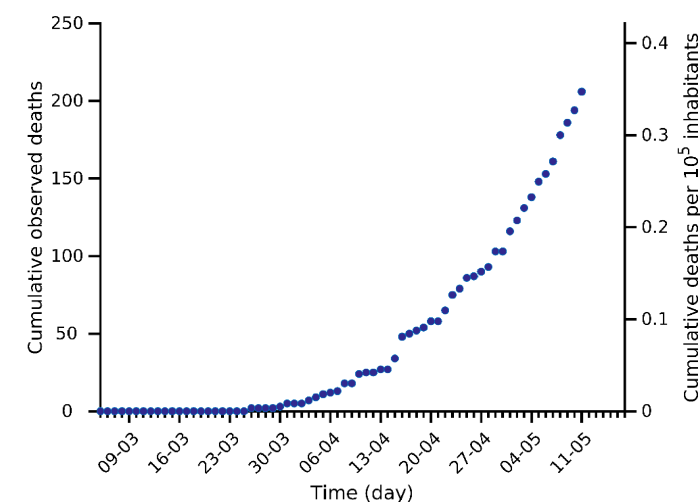
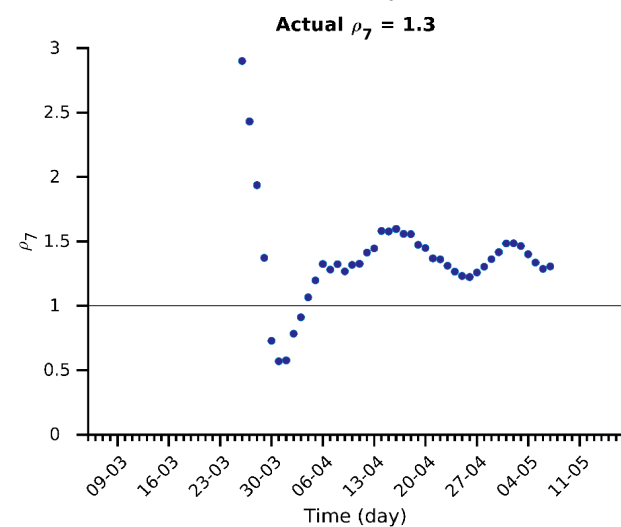
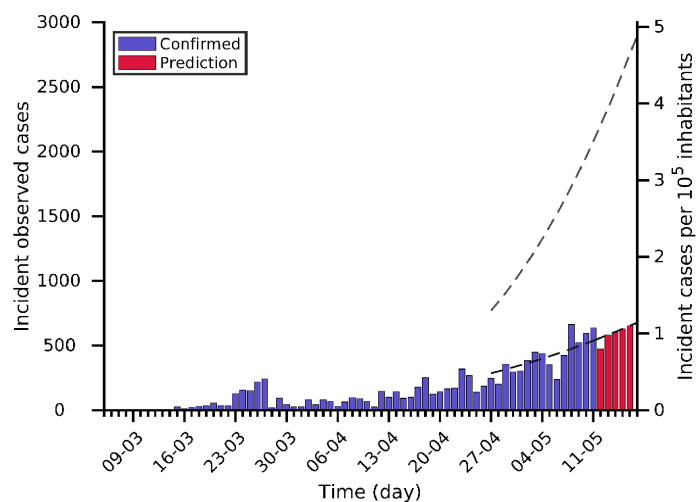
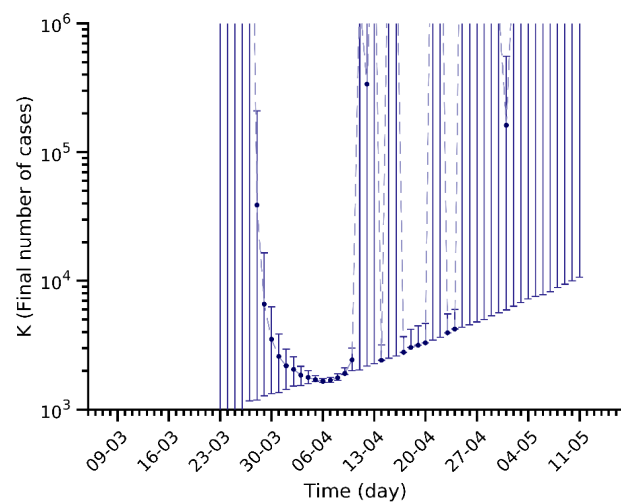
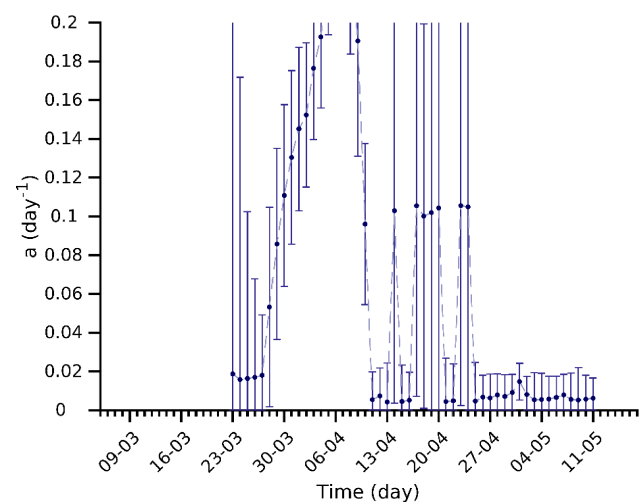
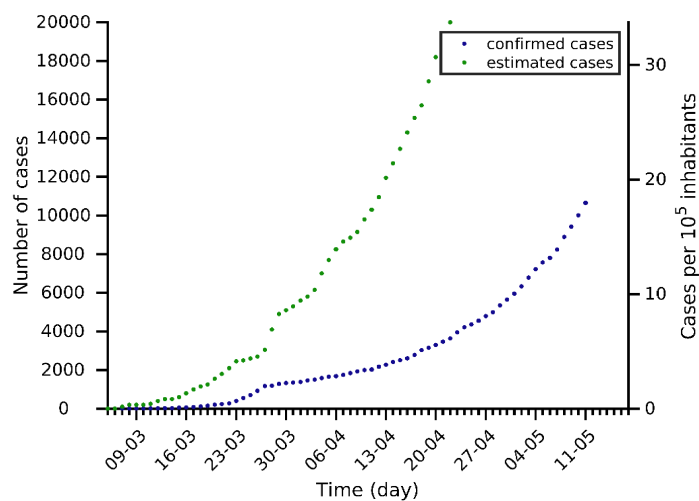
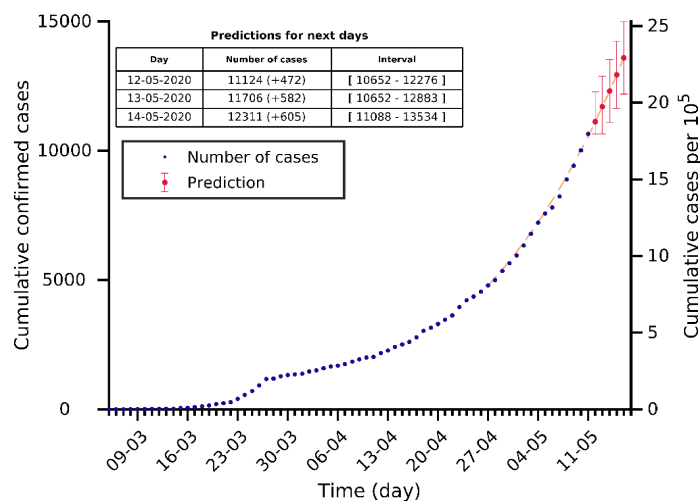
Philippines 11-05-2020. Population: 109.6M. Current cumulated incidence: 10/10⁵



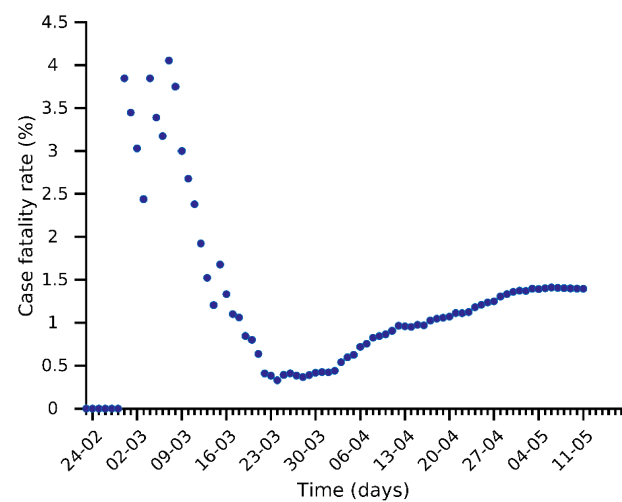
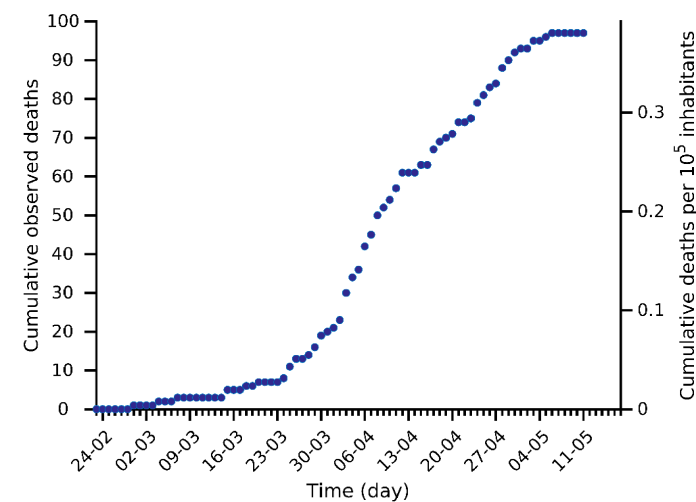
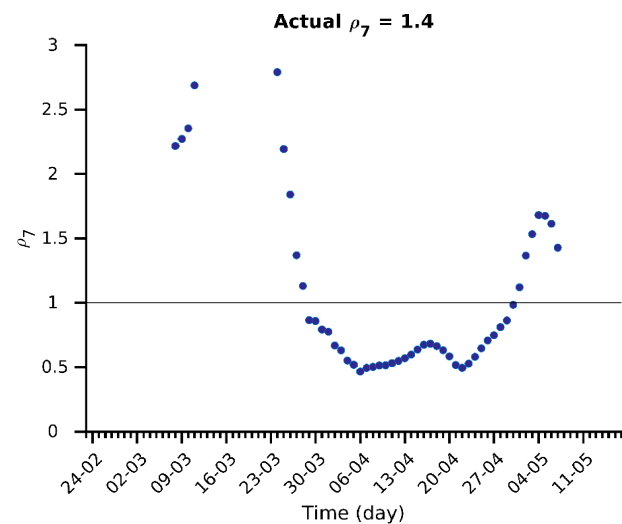
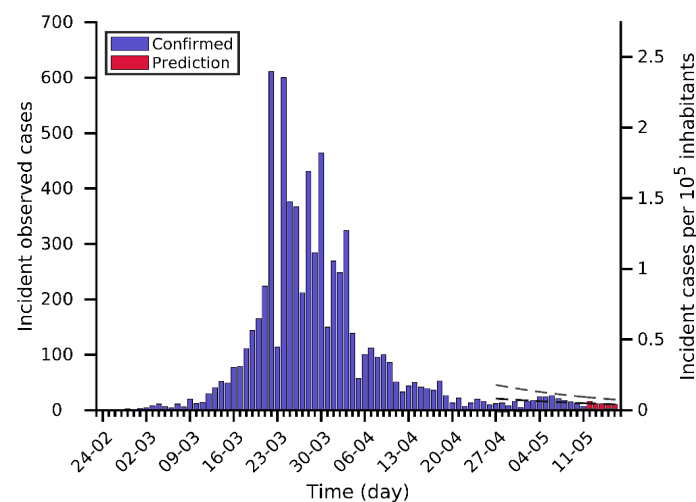
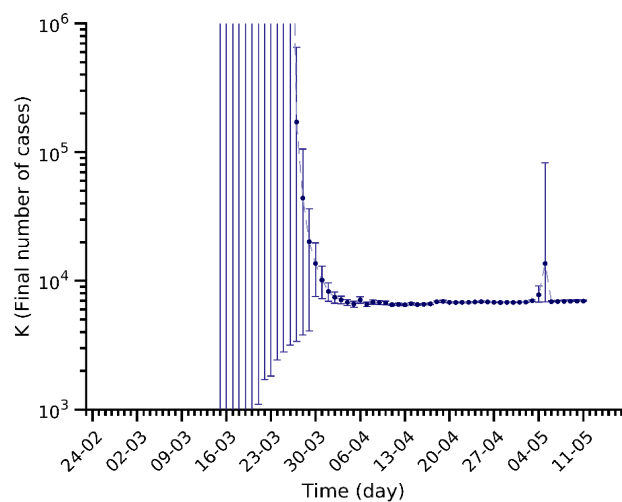
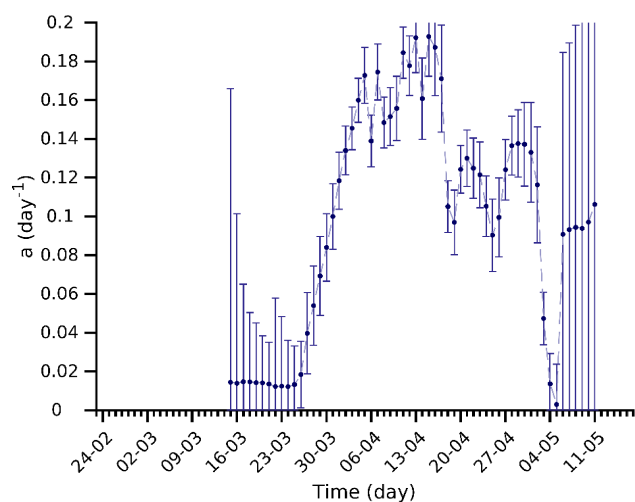
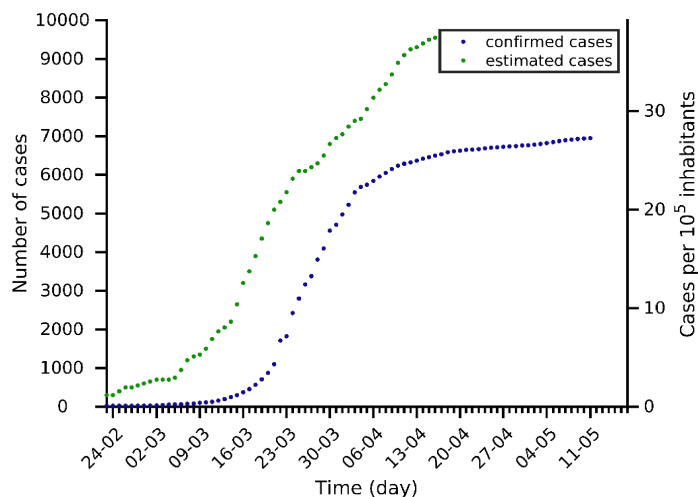
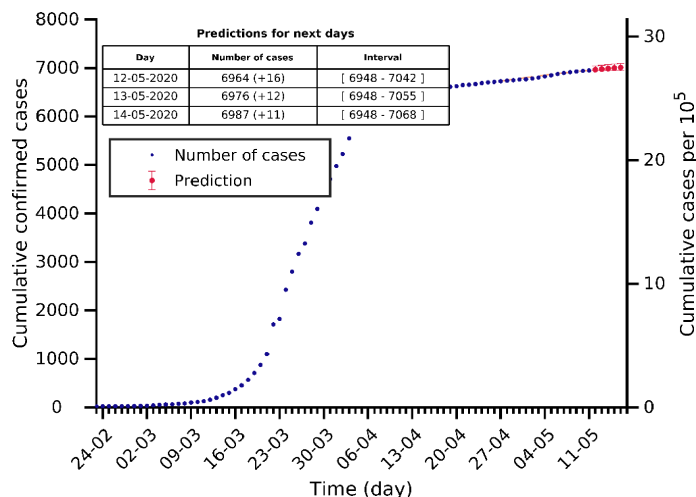
South Korea 11-05-2020. Population: 51.3M. Current cumulated incidence: 21/10⁵



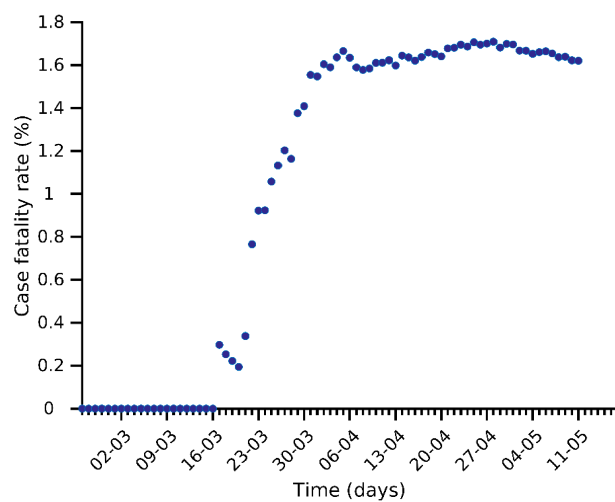
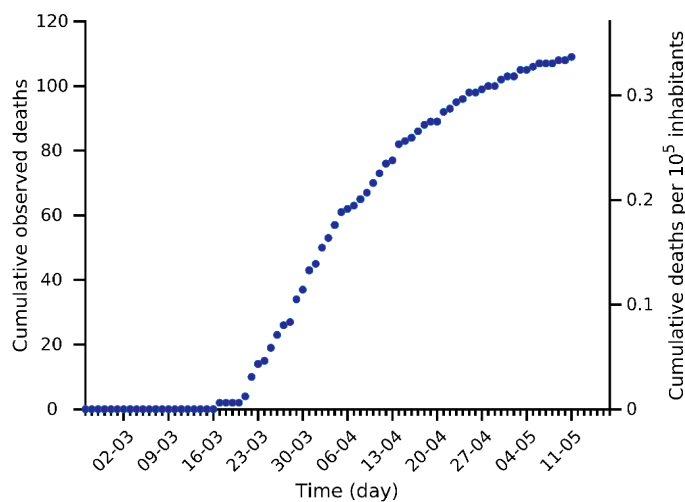
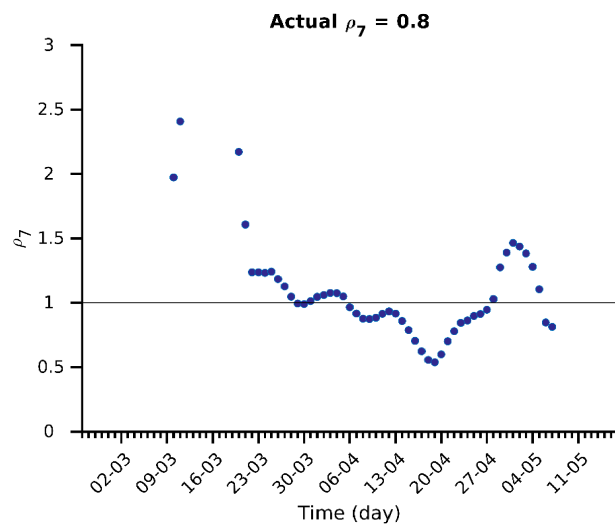
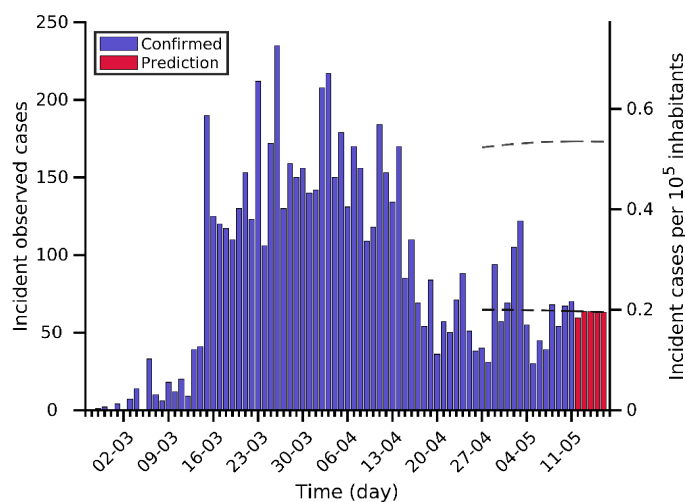
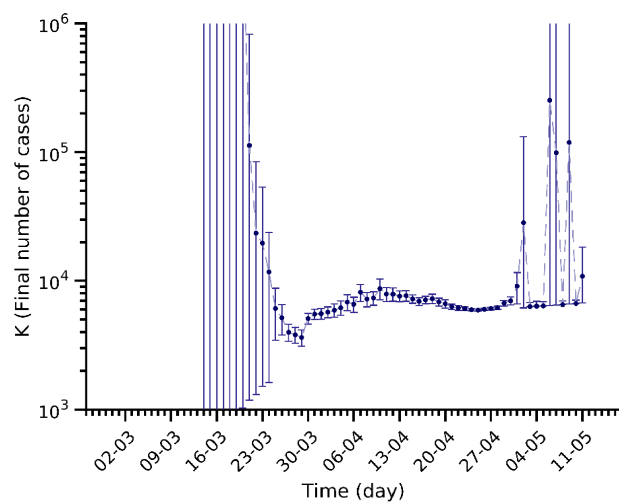
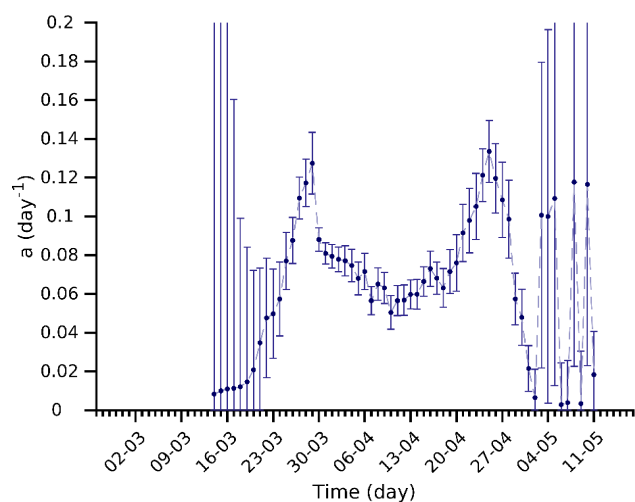
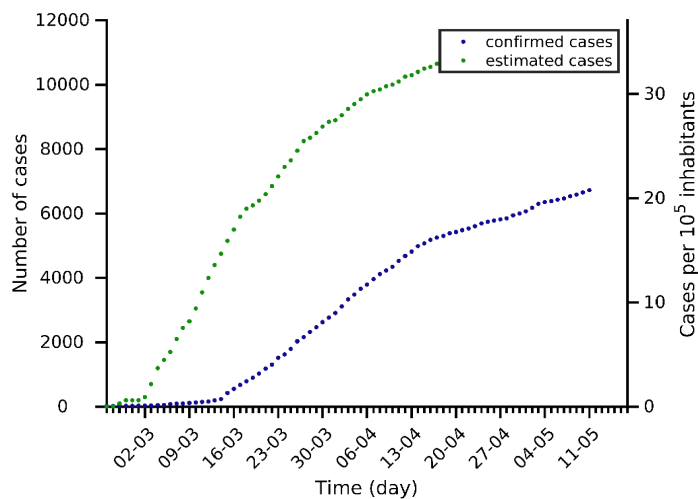
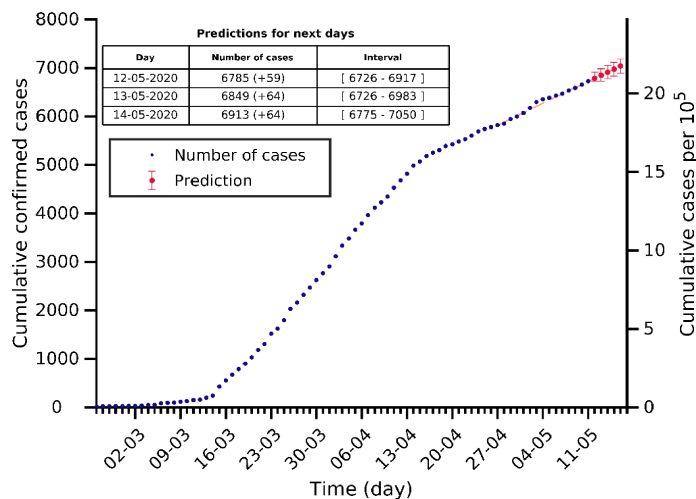
South Africa 11-05-2020. Population: 59.3M. Current cumulated incidence: 18/10⁵



Australia 11-05-2020. Population: 25.5M. Current cumulated incidence: 27/10⁵



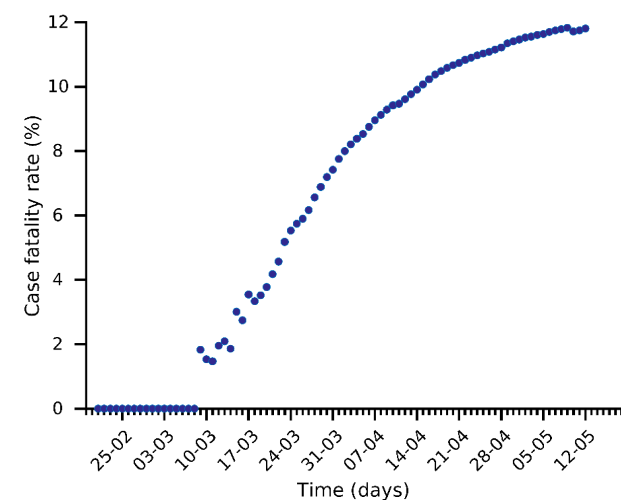
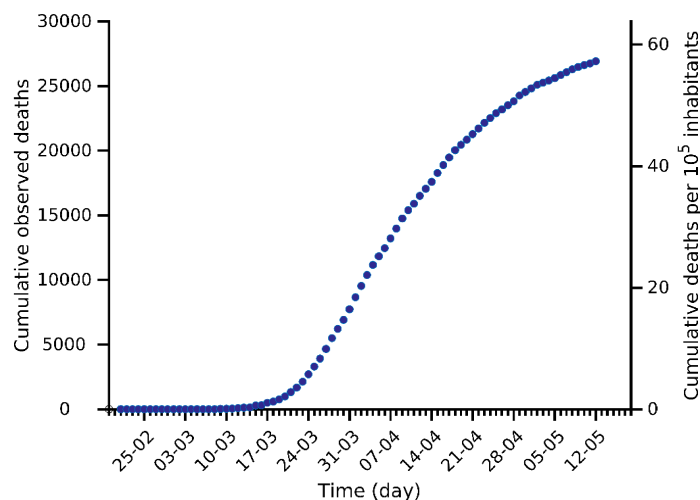
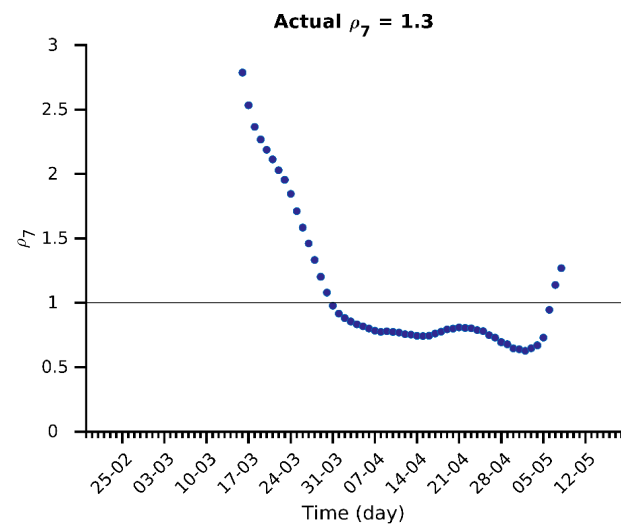
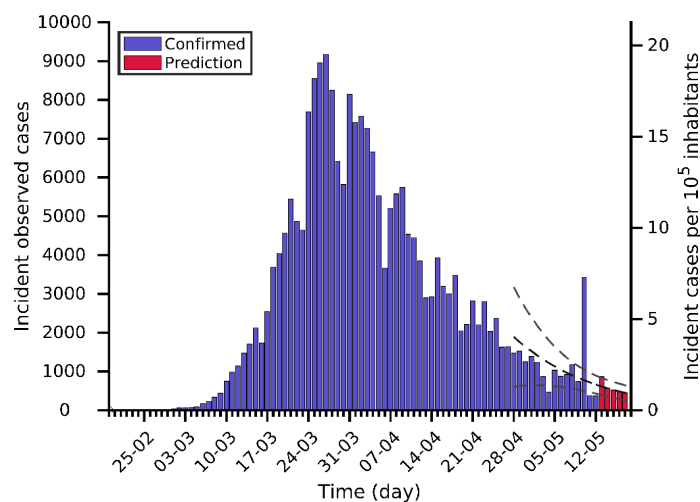
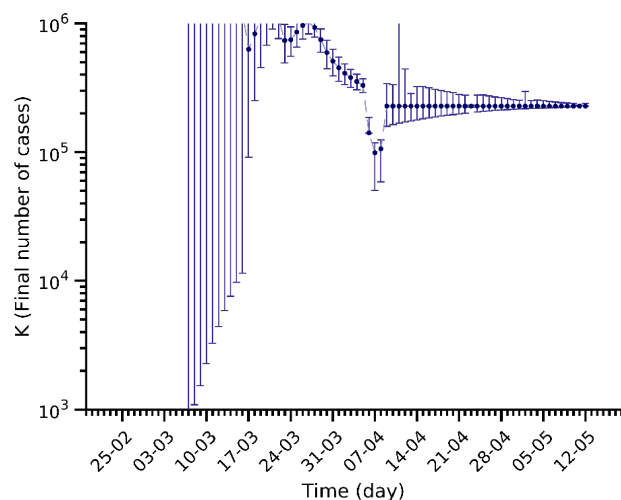
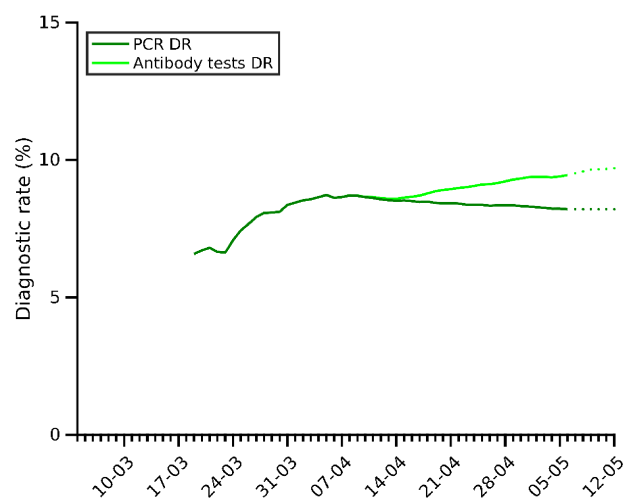
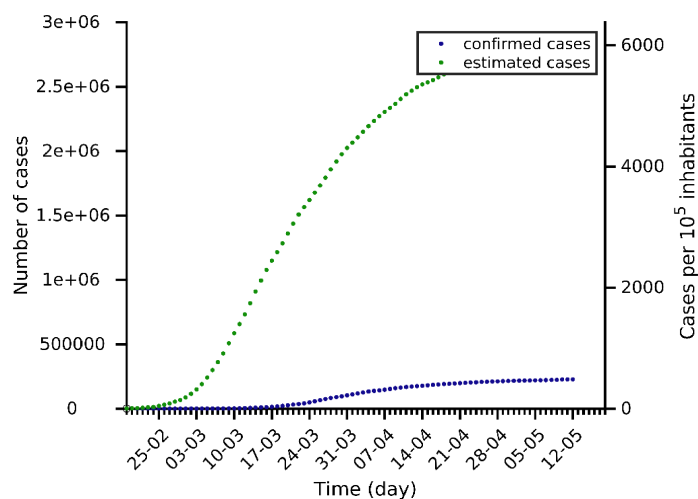
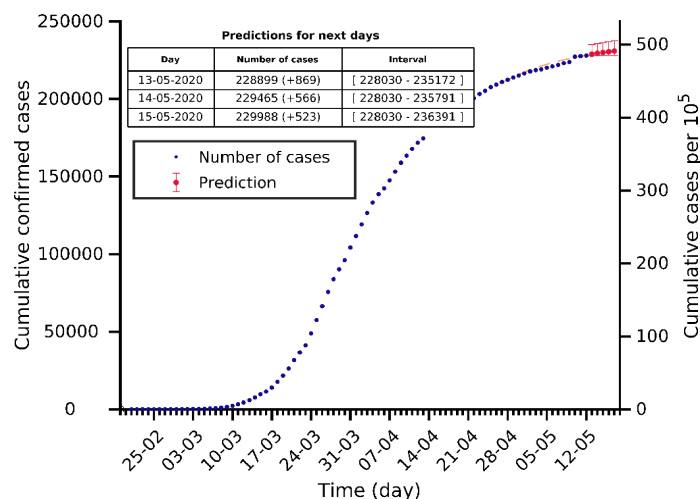
Malaysia 11-05-2020. Population: 32.4M. Current cumulated incidence: 21/10⁵



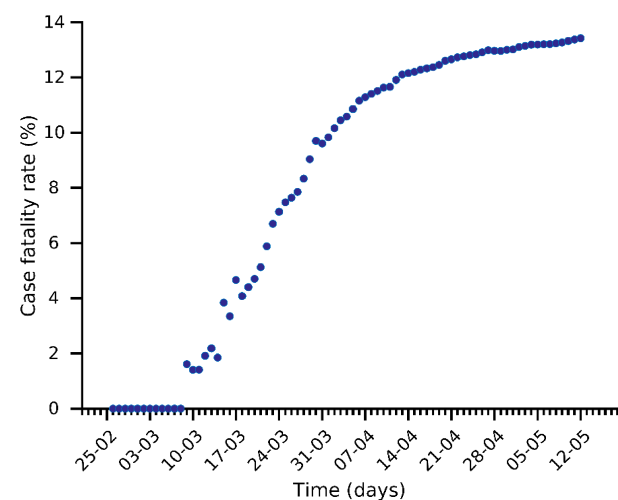
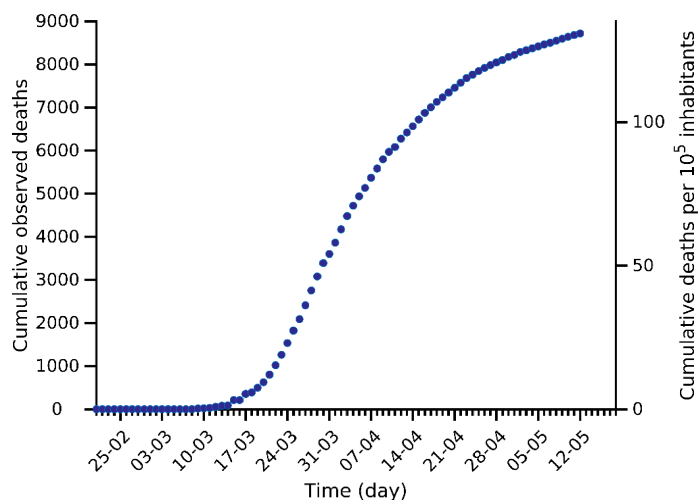
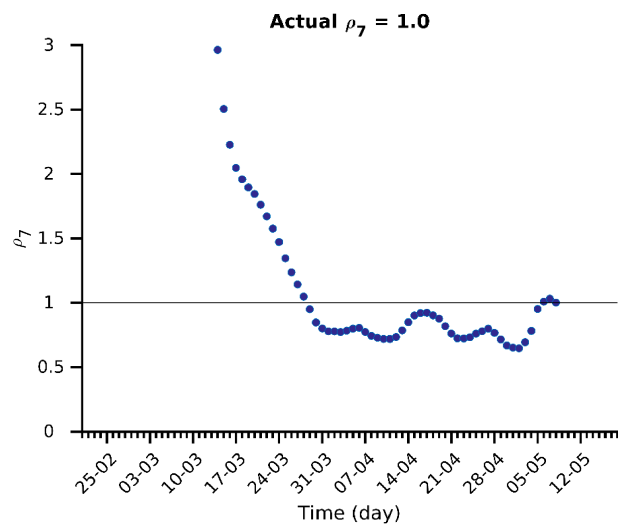
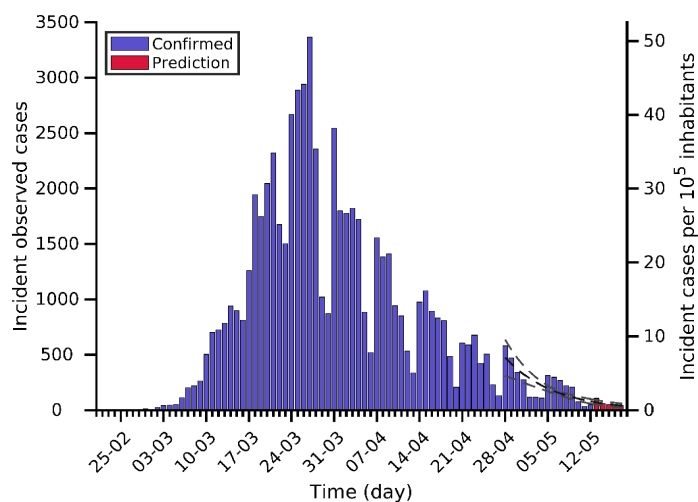
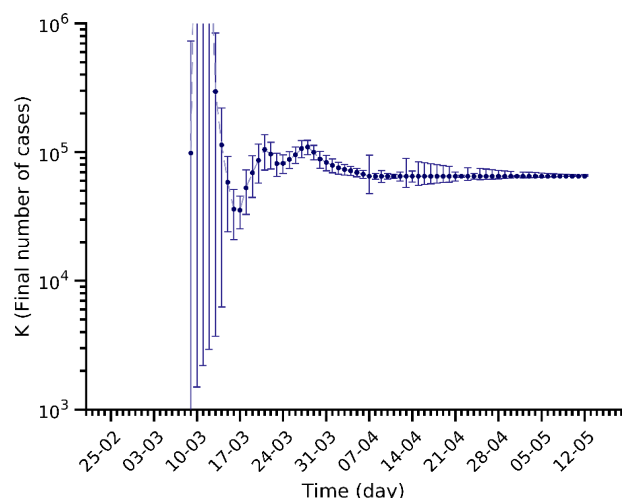
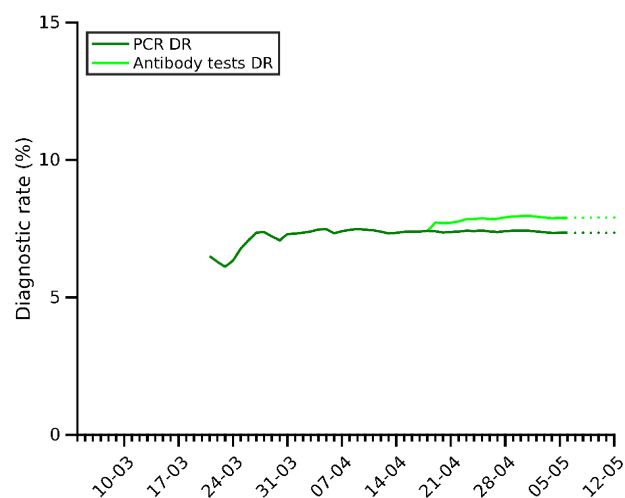
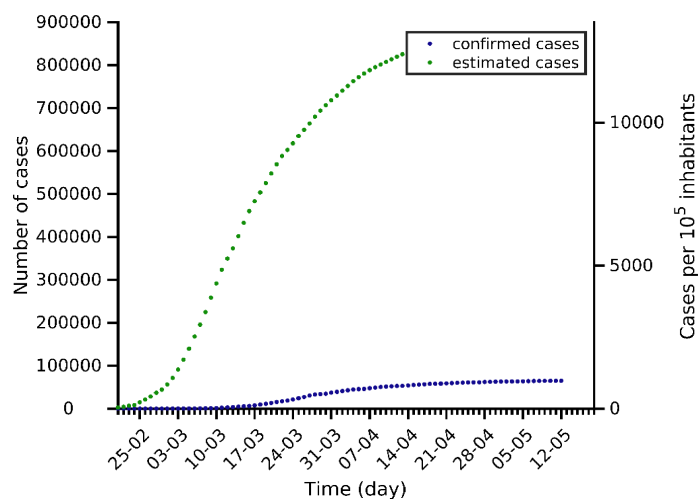
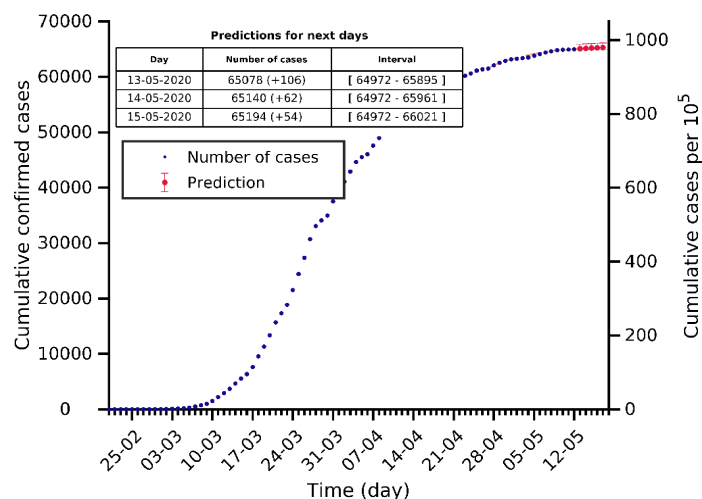
(3) Analysis and prediction of COVID-19 for Spain and its autonomous communities

Data obtained from <https://github.com/datadista/datasets/tree/master/COVID%2019> and
<https://covid19.isciii.es/>

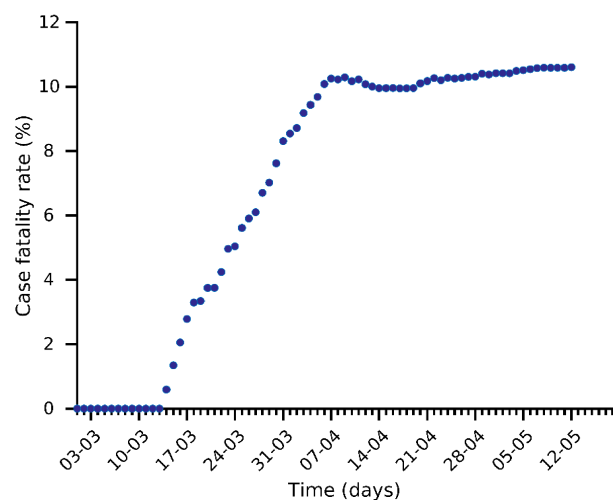
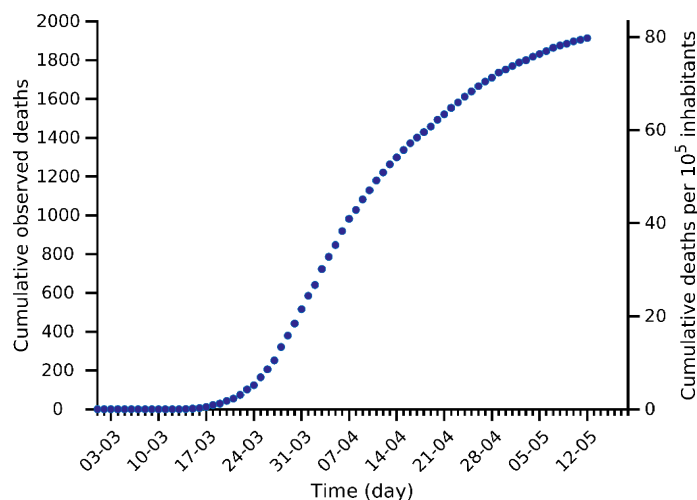
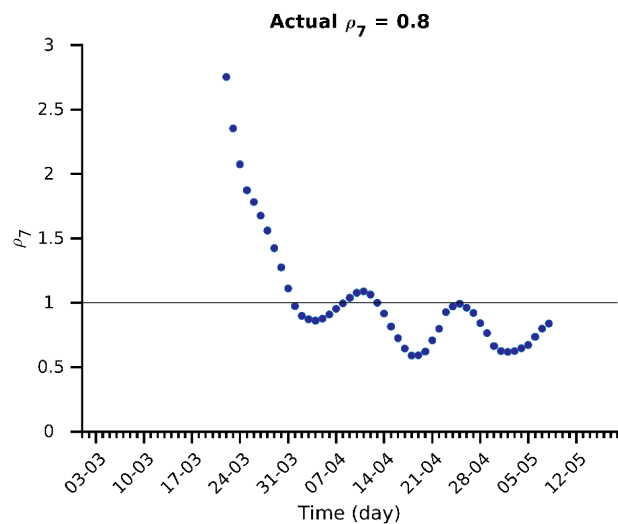
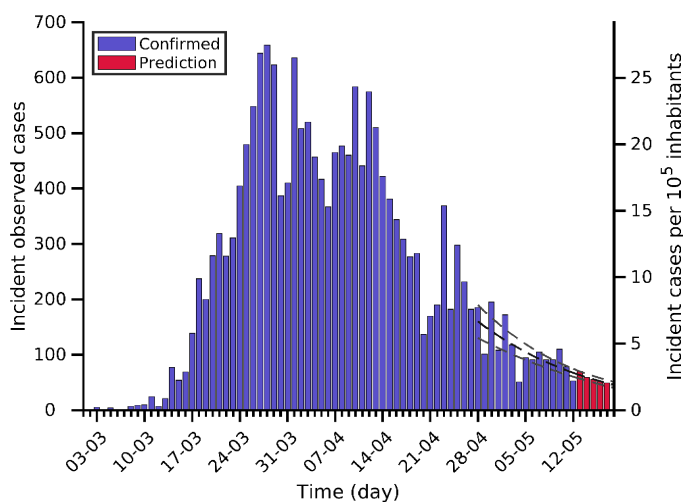
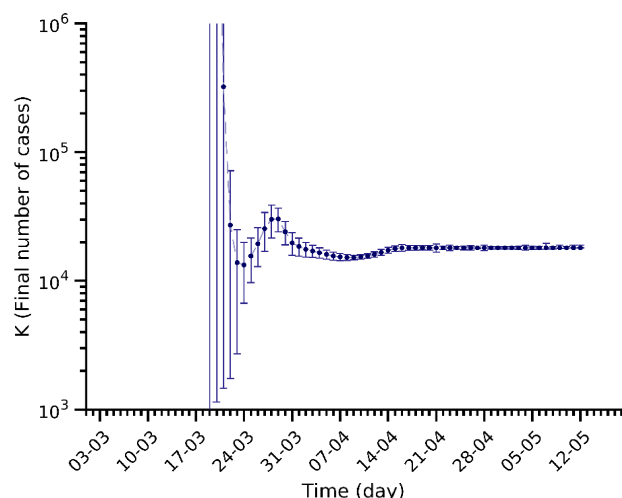
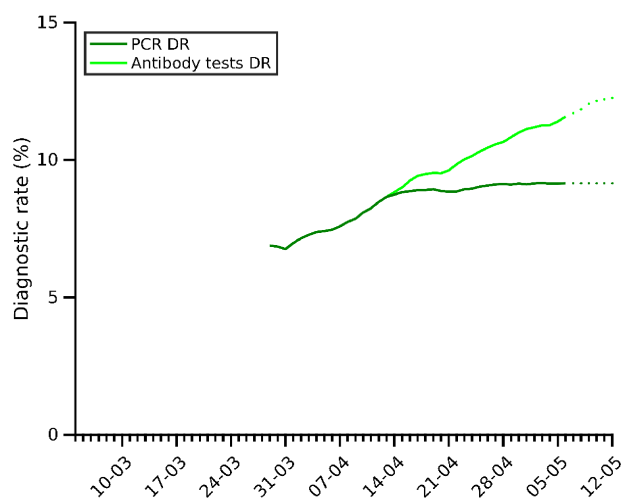
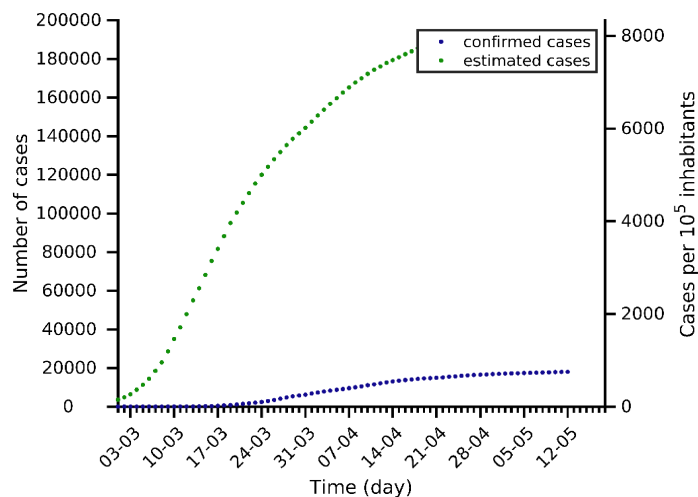
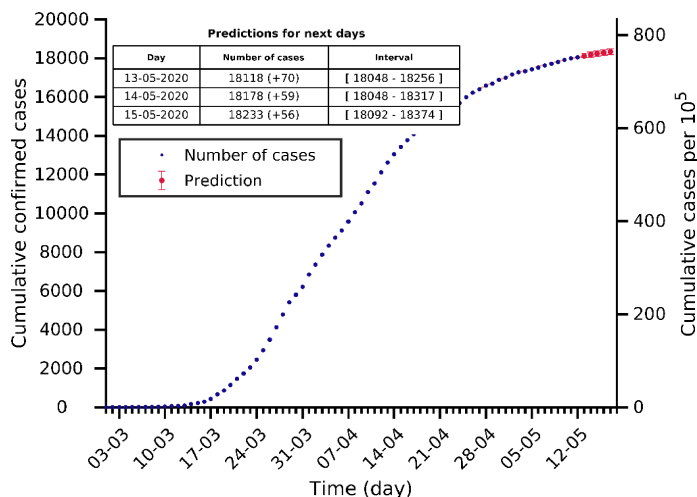
Spain 12-05-2020. Population: 47.0M. Current cumulated incidence: 485/10⁵



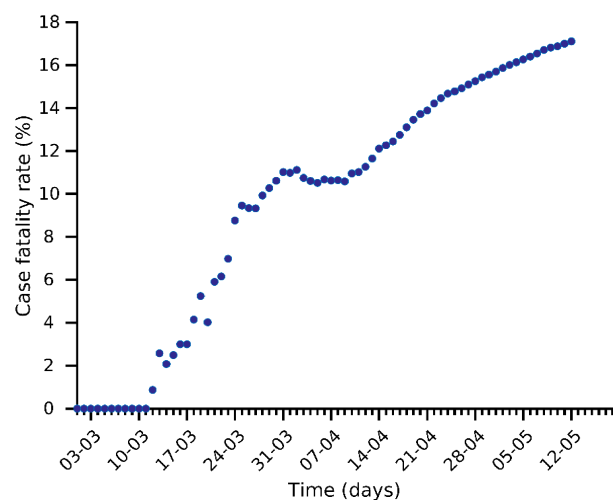
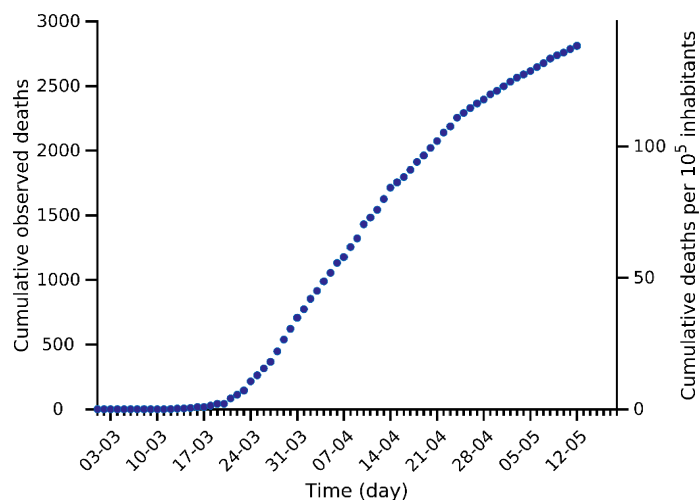
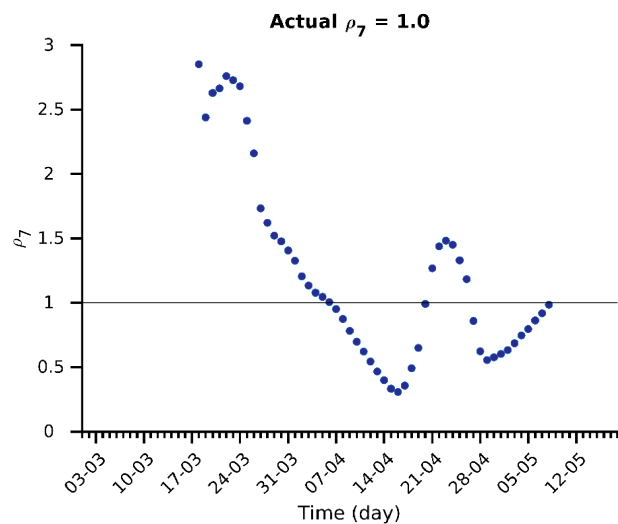
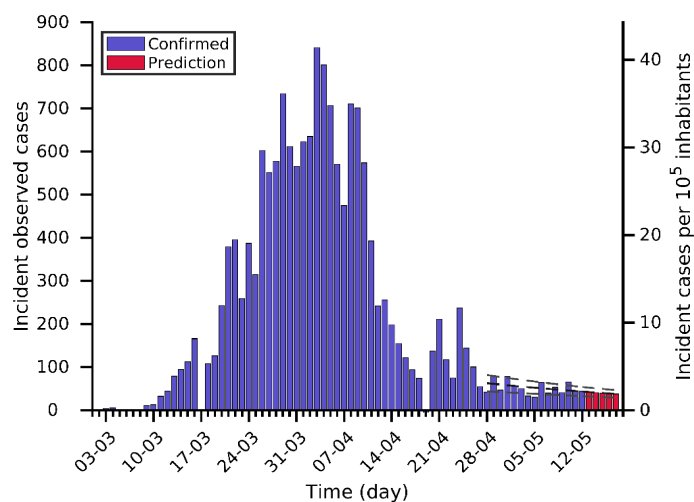
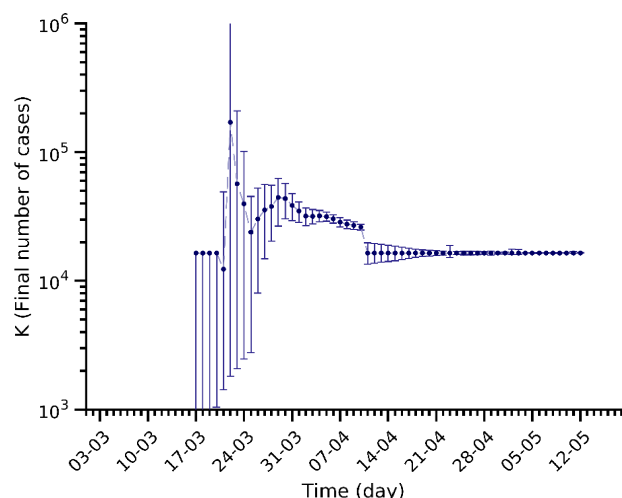
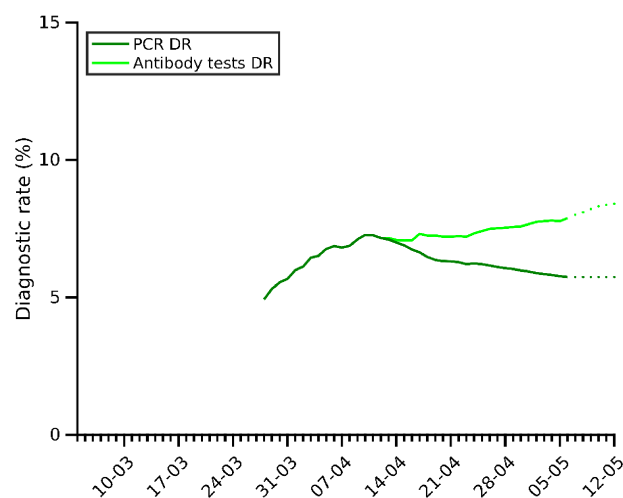
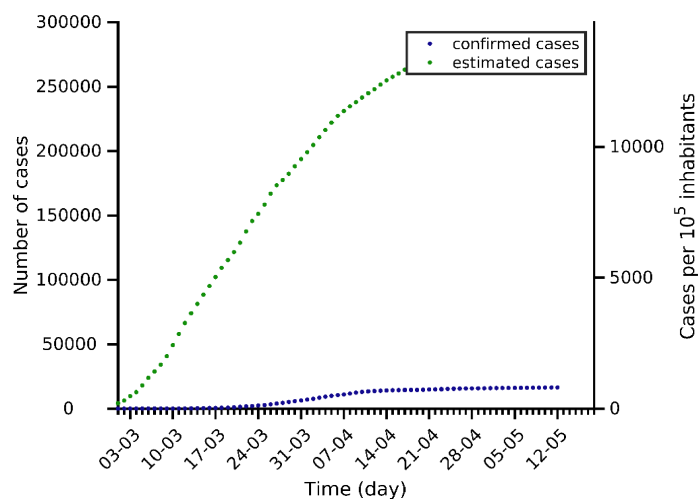
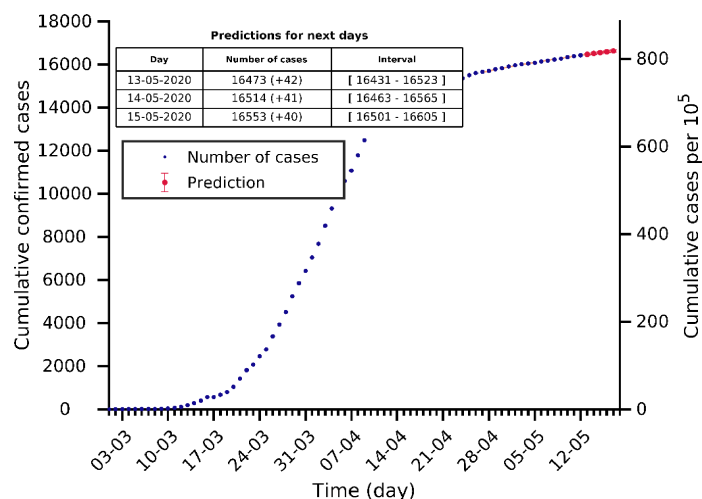
Madrid 12-05-2020. Population: 6.7M. Current cumulated incidence: 975/10⁵



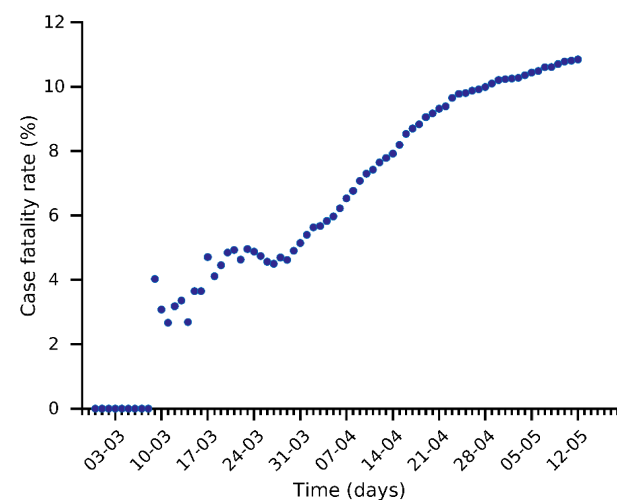
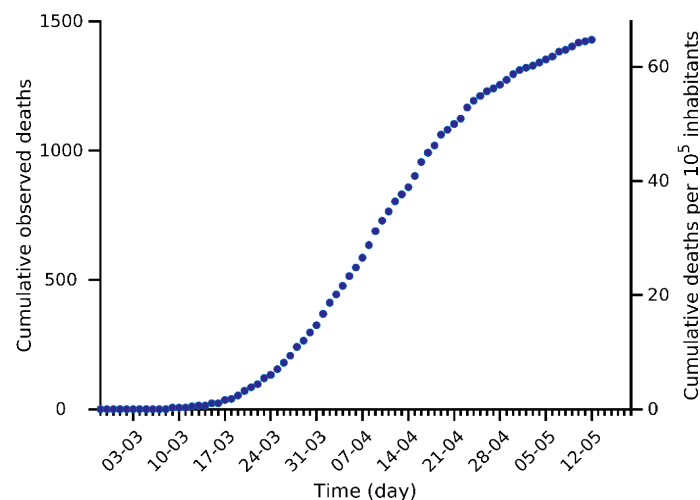
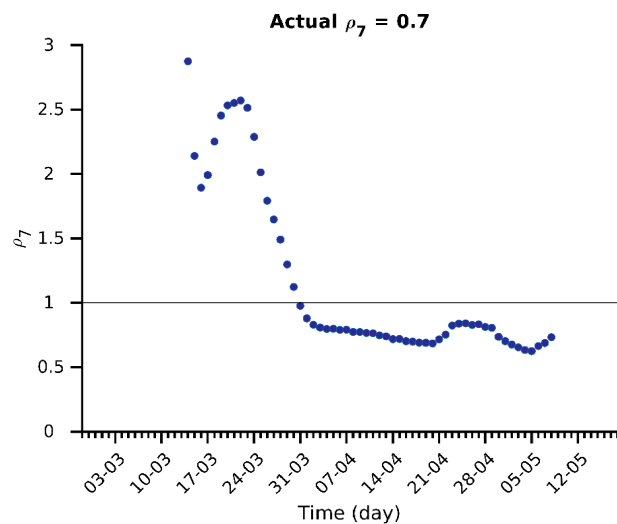
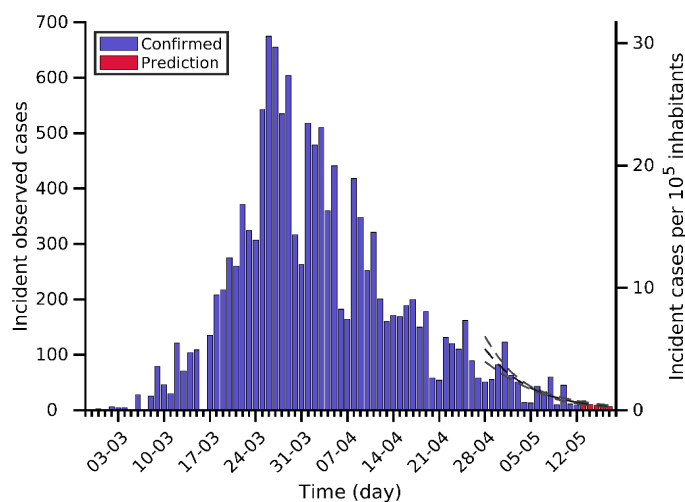
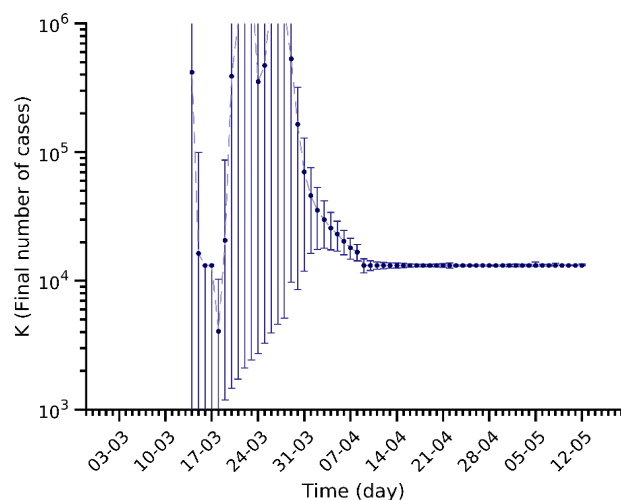
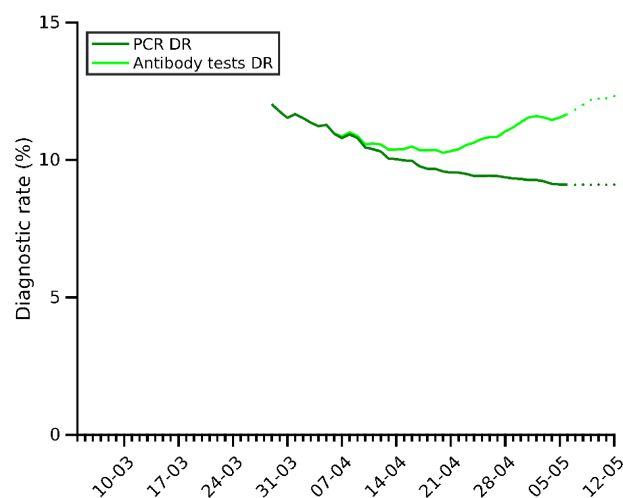
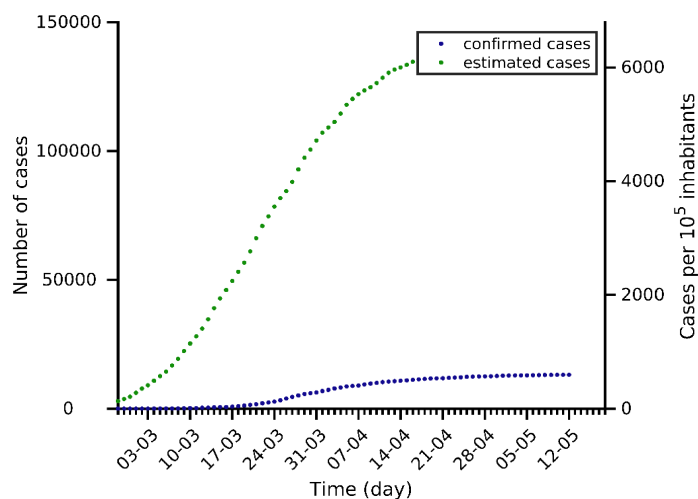
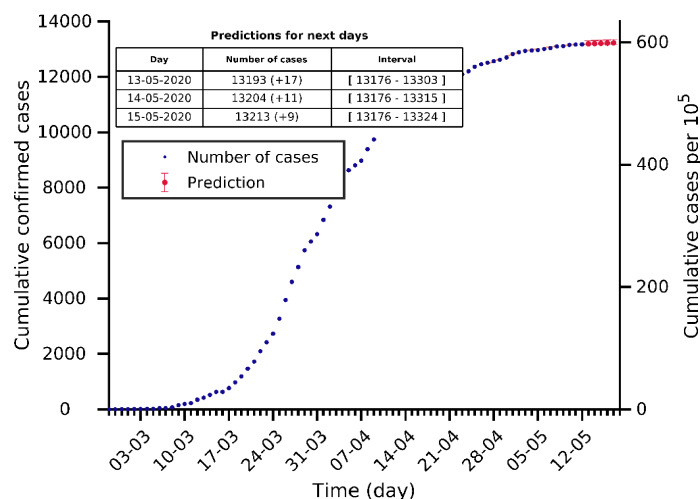
Castilla Leon 12-05-2020. Population: 2.4M. Current cumulated incidence: 752/10⁵



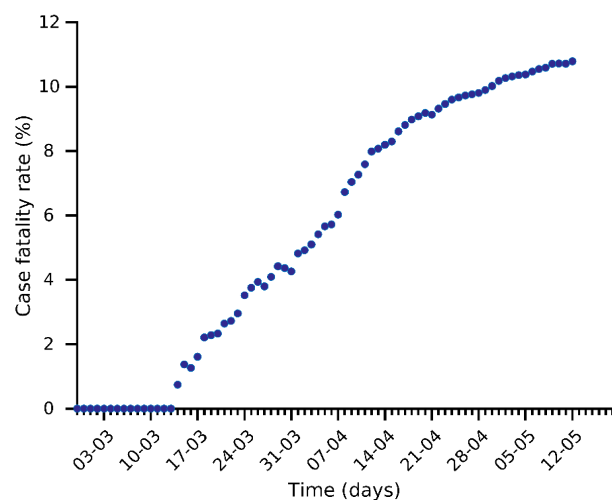
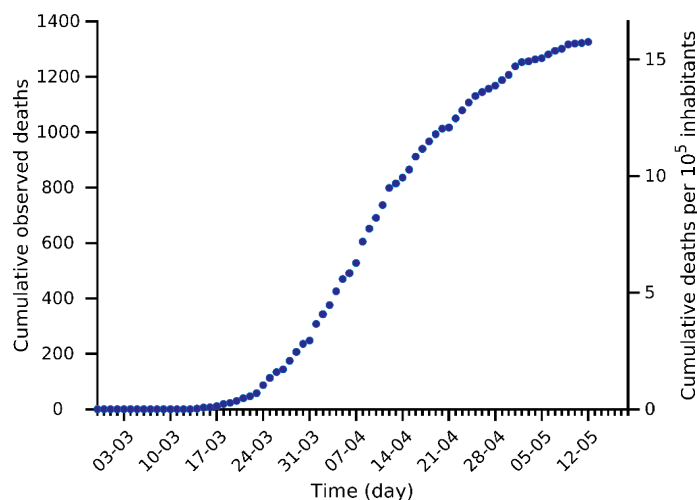
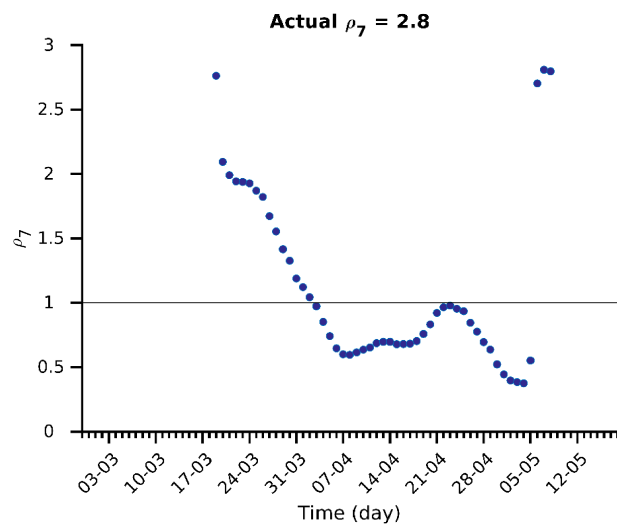
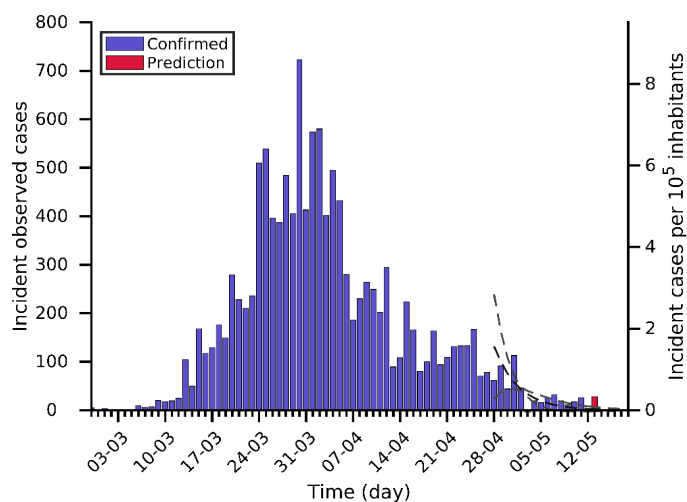
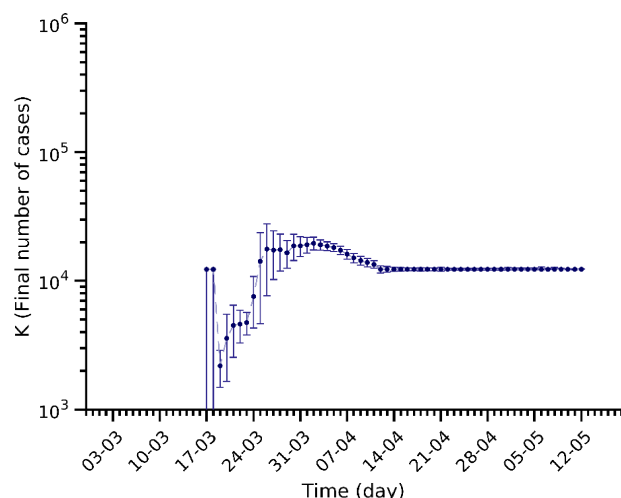
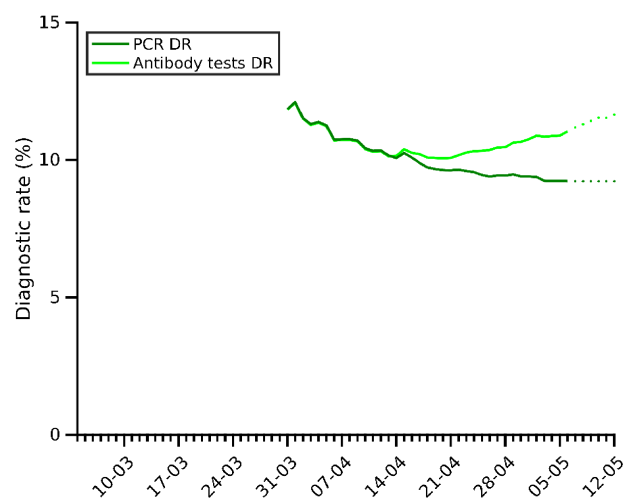
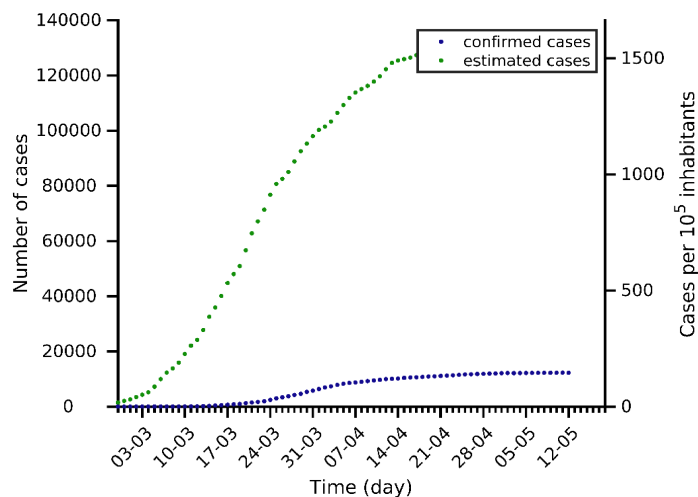
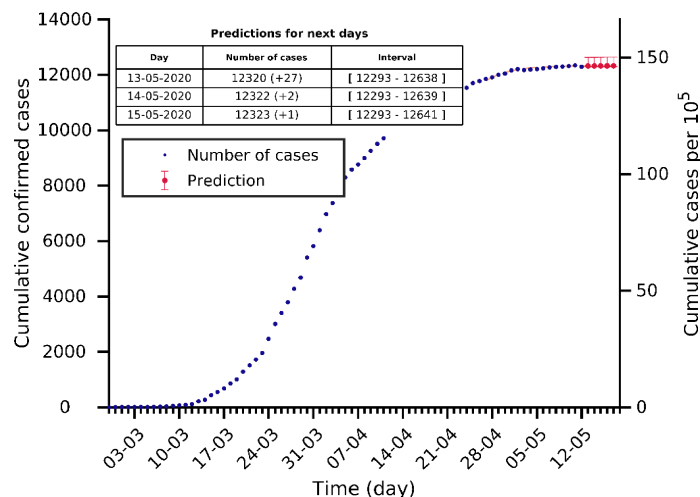
Castilla-La Mancha 12-05-2020. Population: 2.0M. Current cumulated incidence: 80



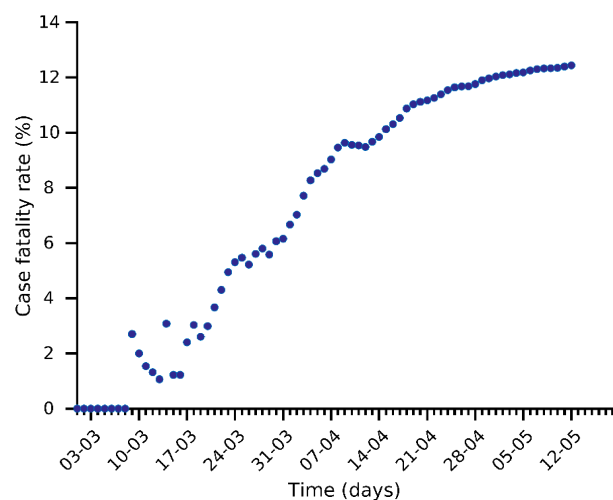
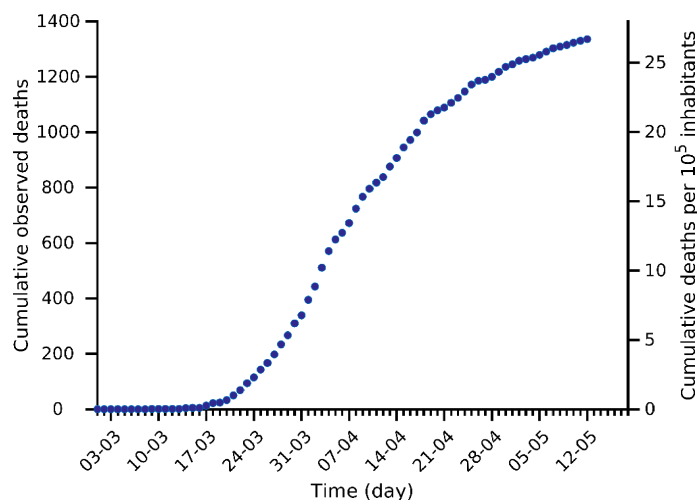
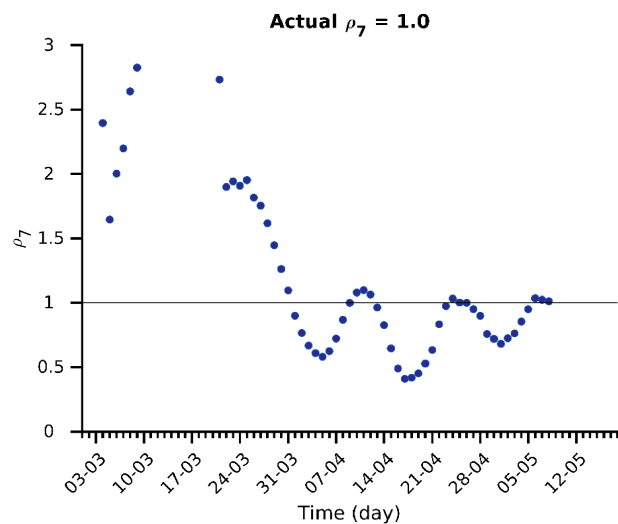
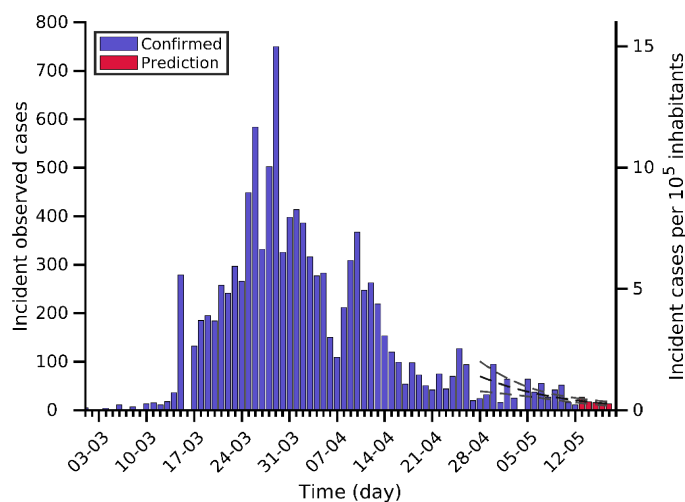
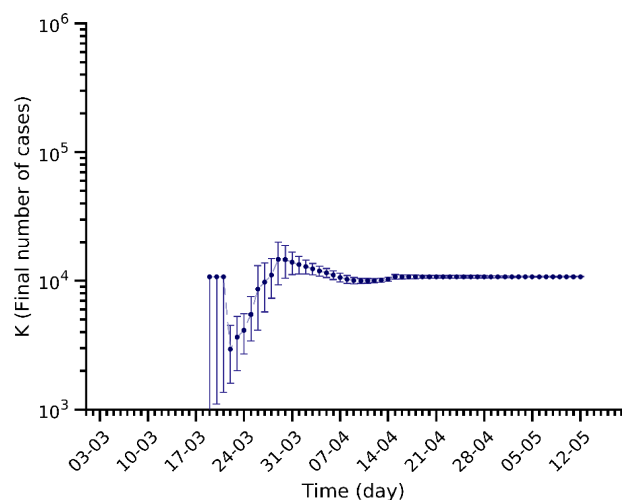
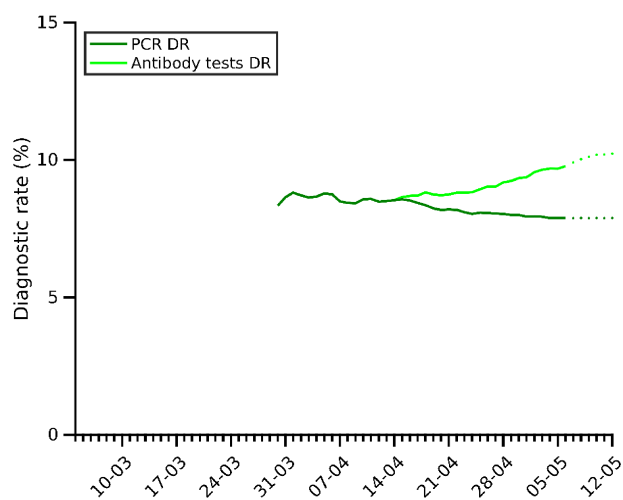
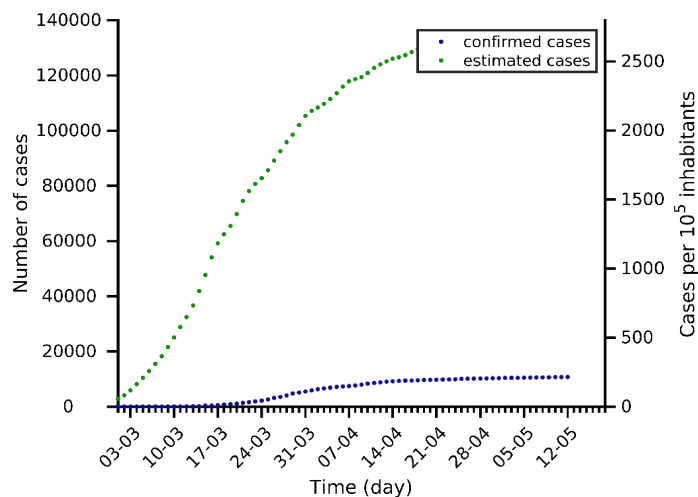
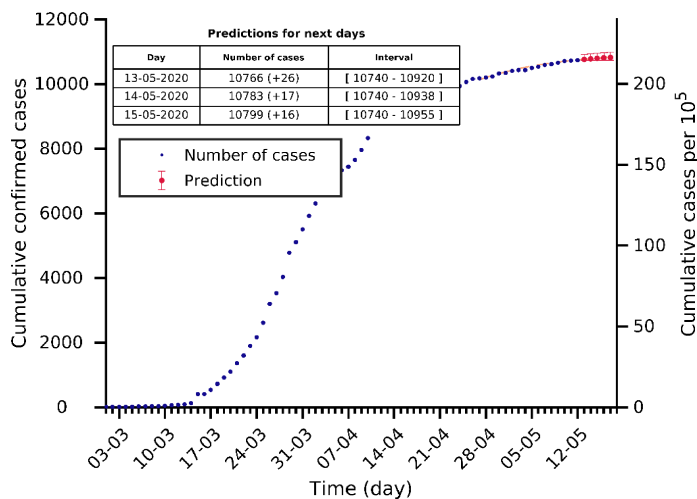
Euskadi 12-05-2020. Population: 2.2M. Current cumulated incidence: 597/10⁵



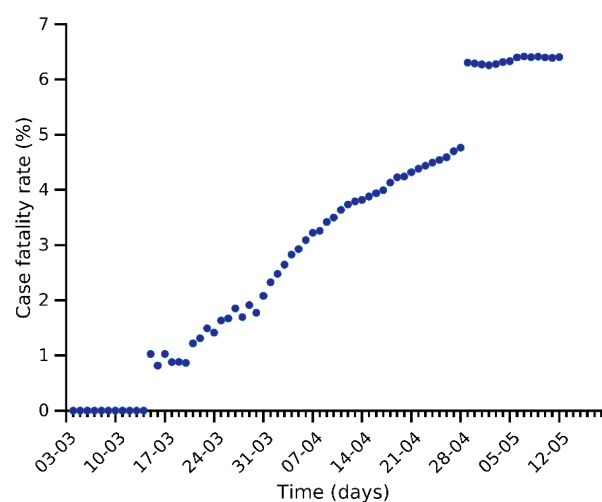
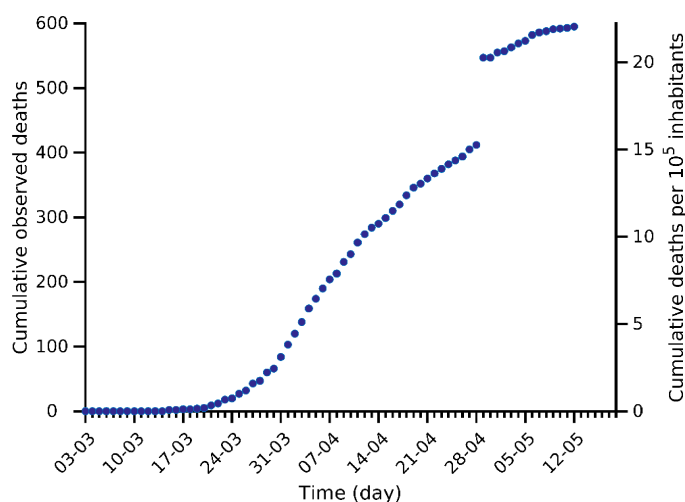
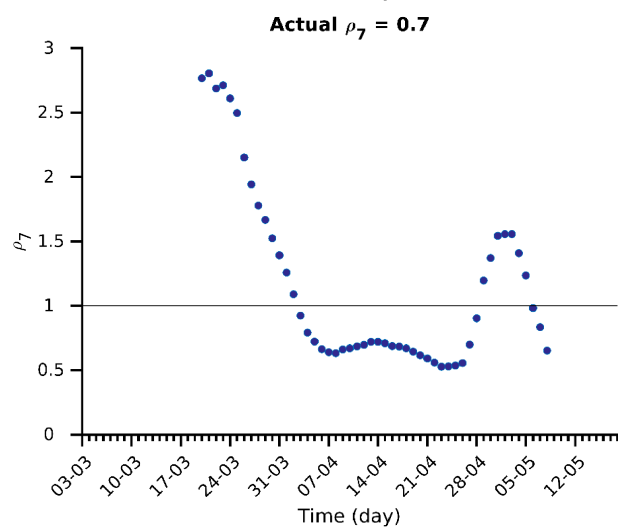
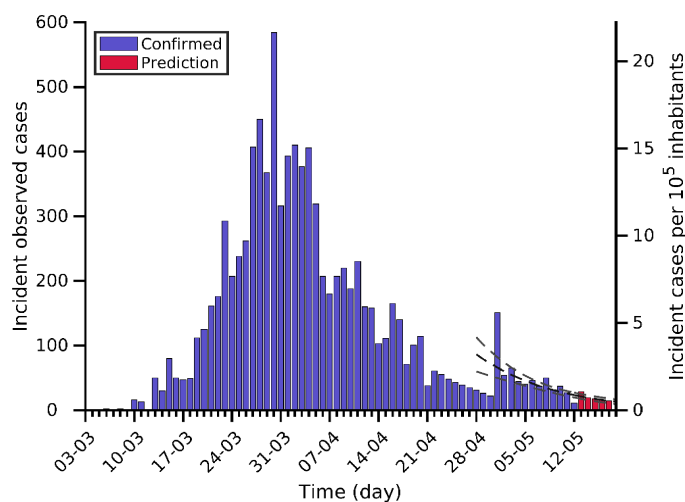
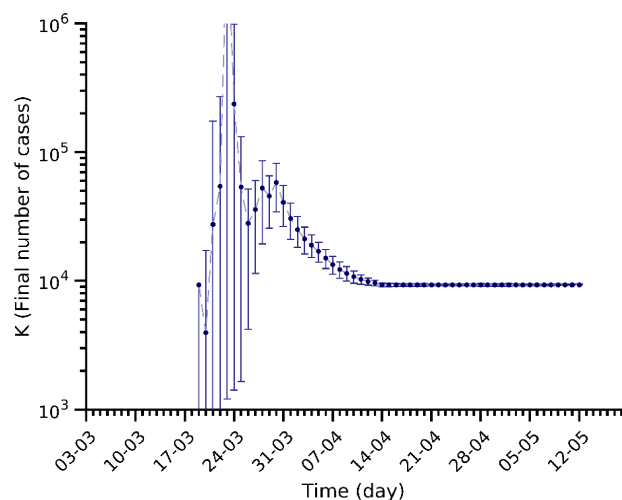
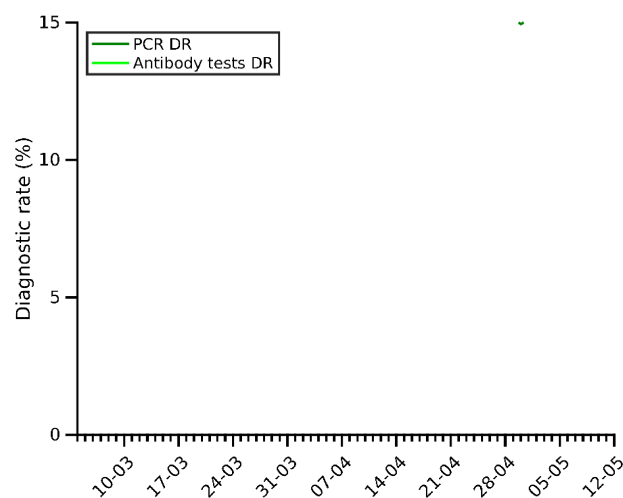
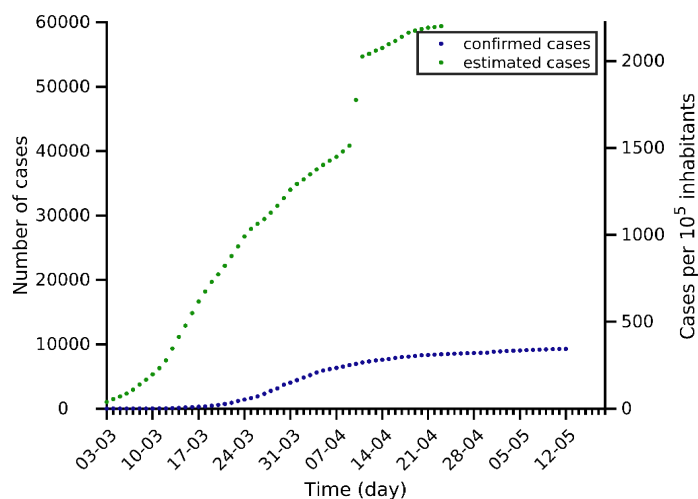
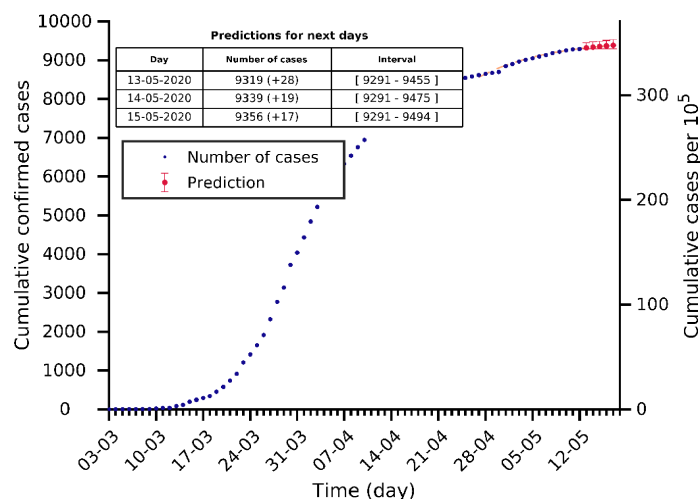
Andalucia 12-05-2020. Population: 8.4M. Current cumulated incidence: 146/10⁵



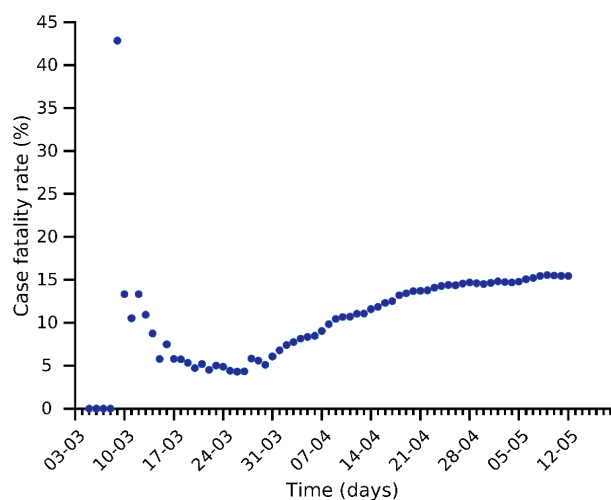
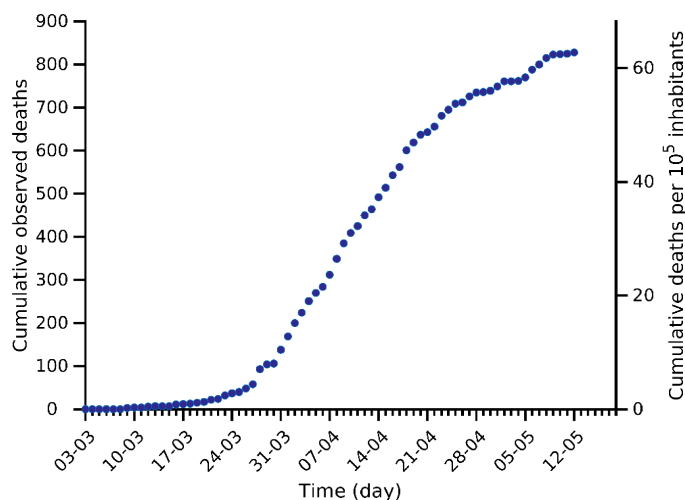
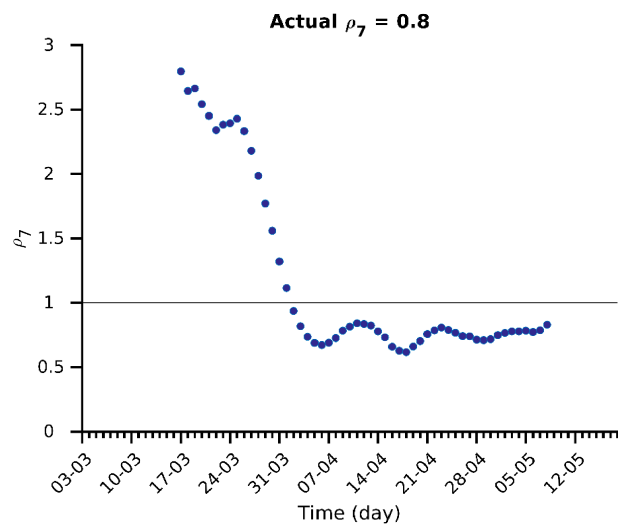
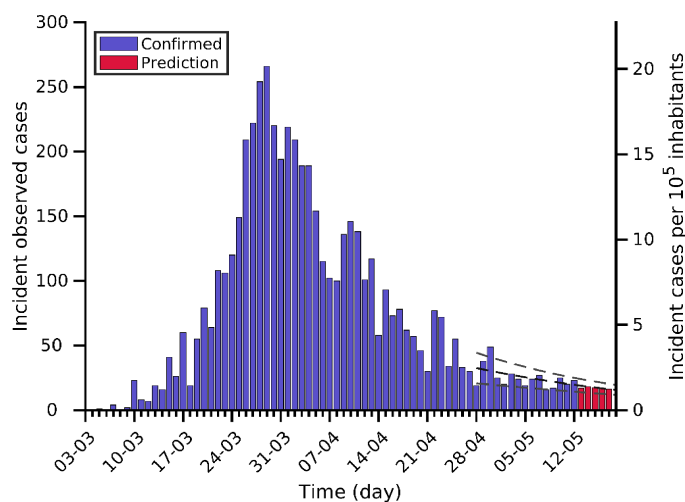
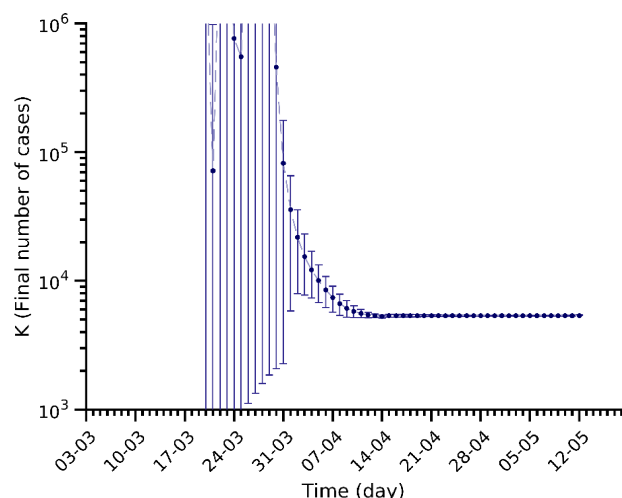
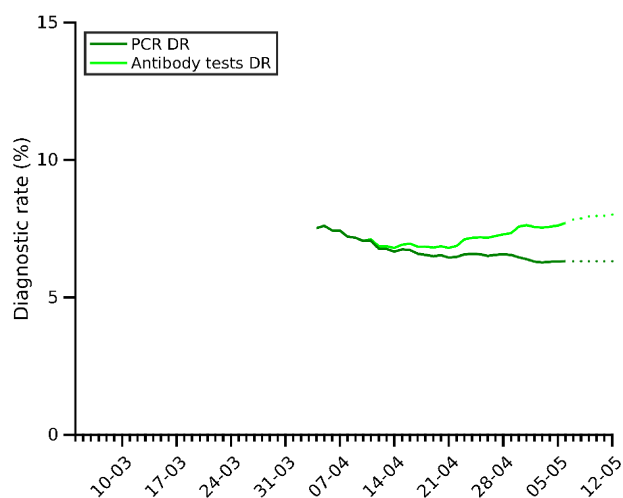
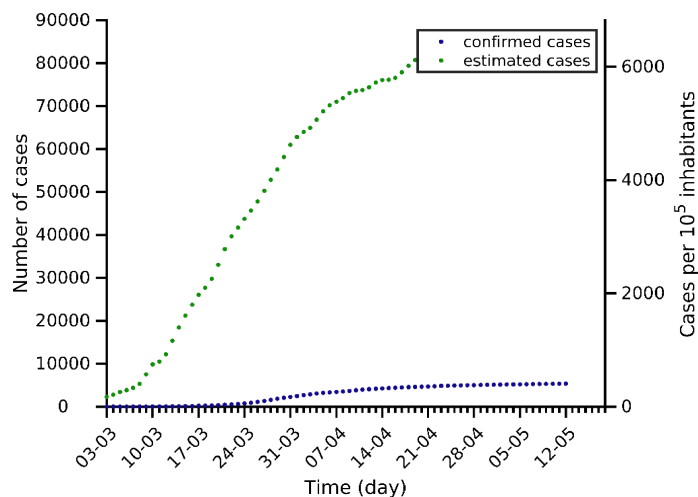
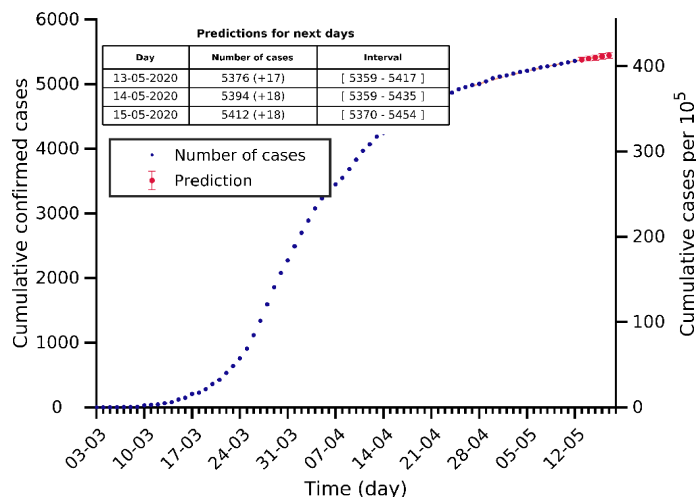
C Valenciana 12-05-2020. Population: 5.0M. Current cumulated incidence: 215/10⁵



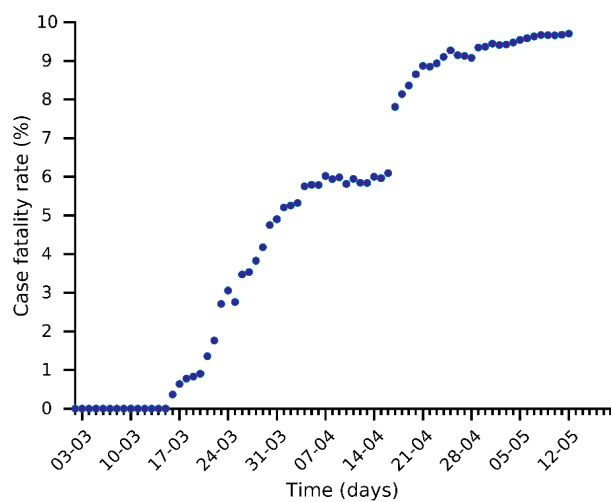
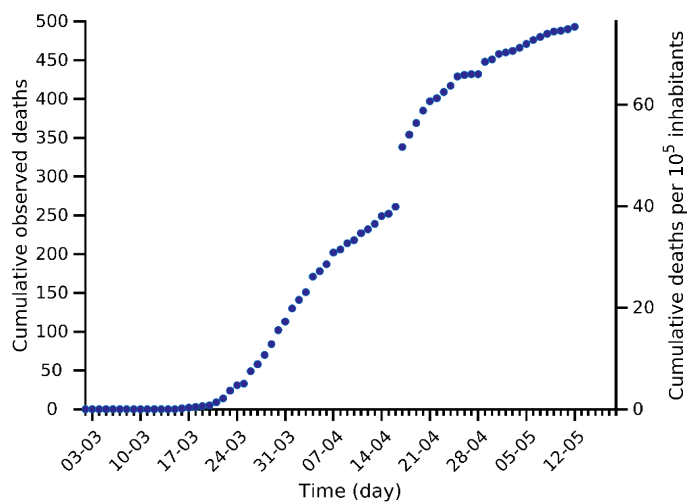
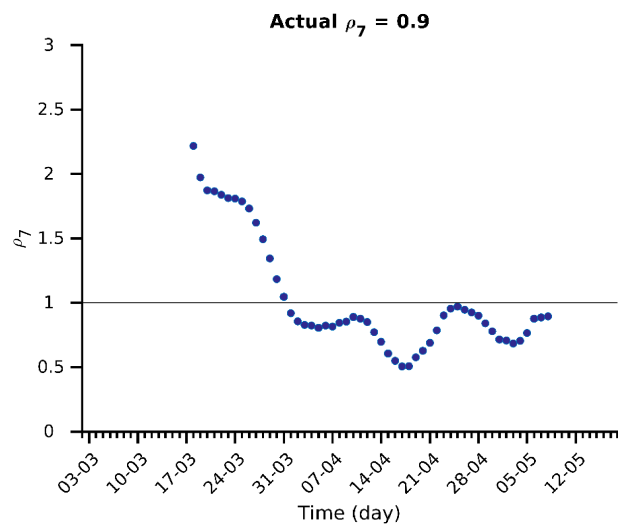
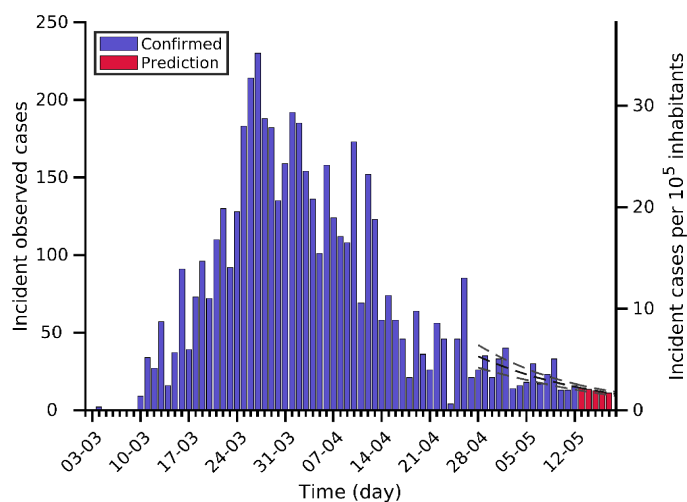
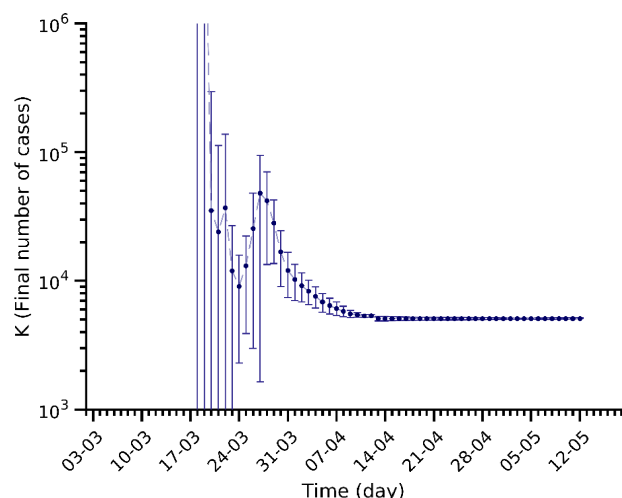
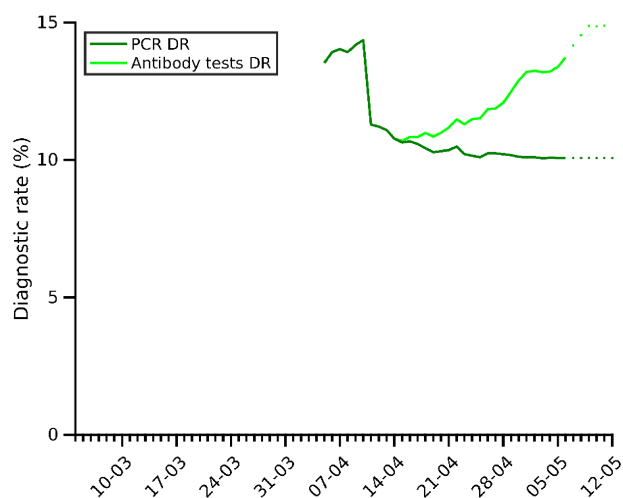
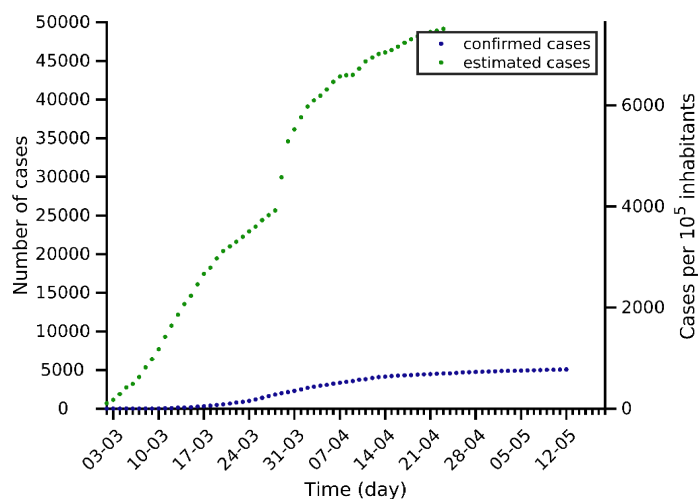
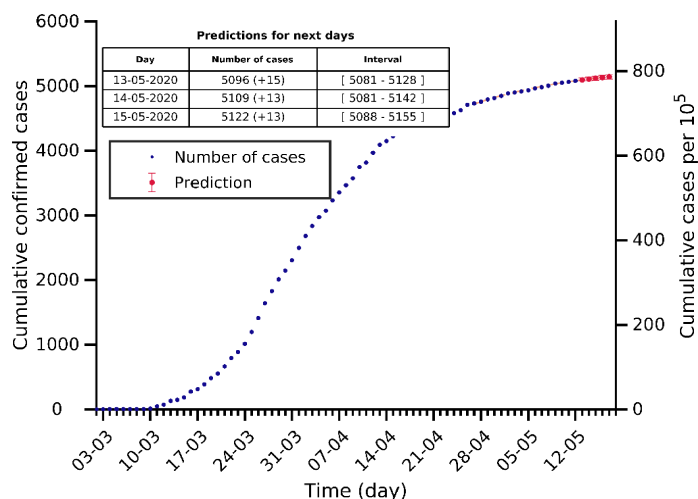
Galicia 12-05-2020. Population: 2.7M. Current cumulated incidence: 344/10⁵



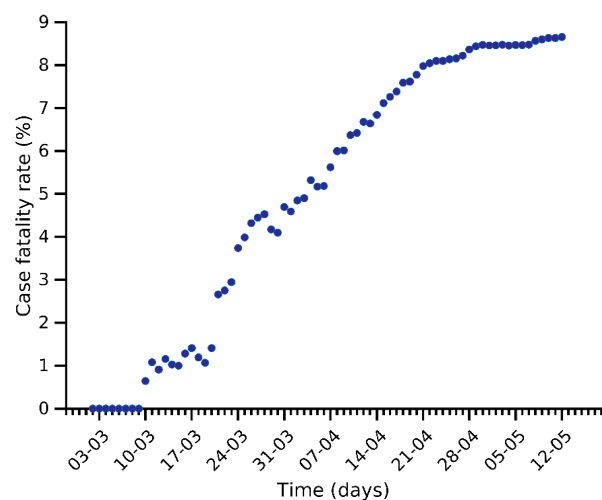
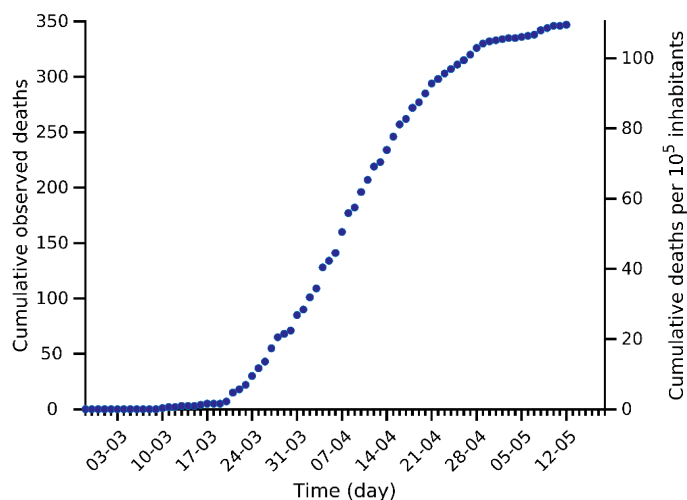
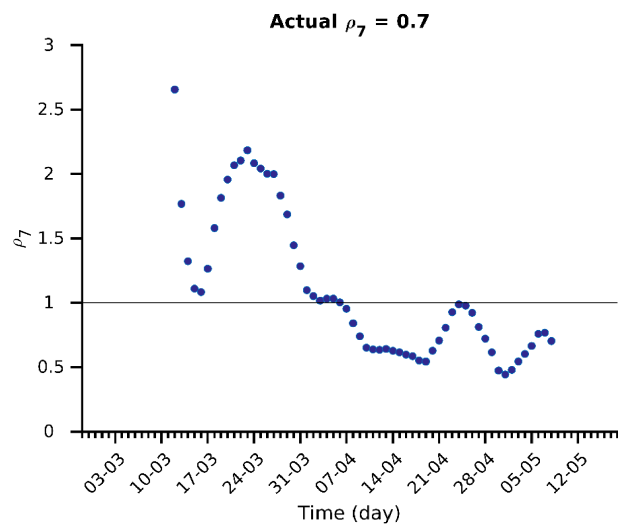
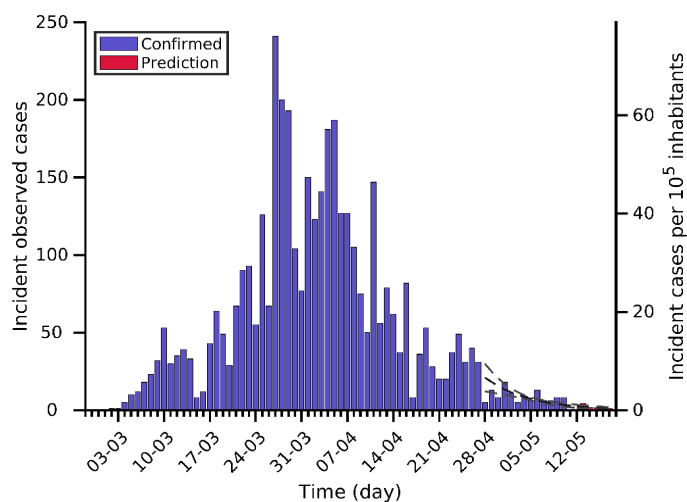
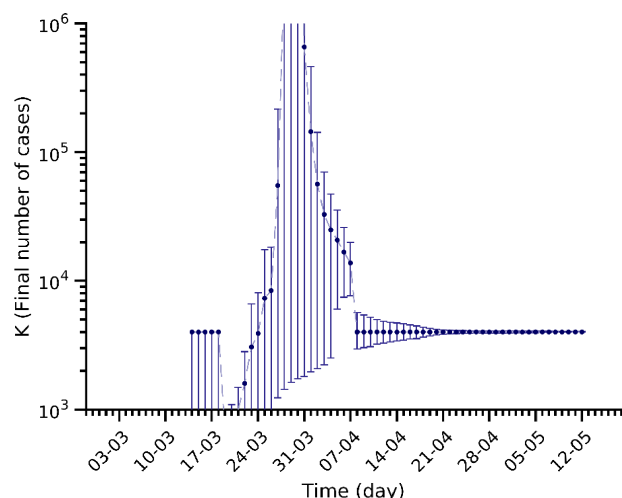
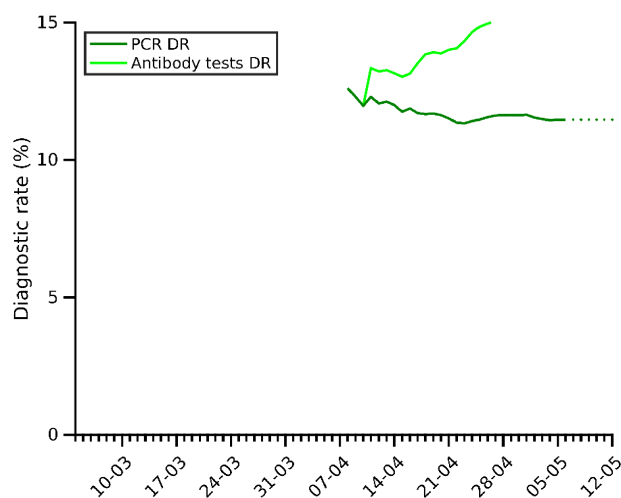
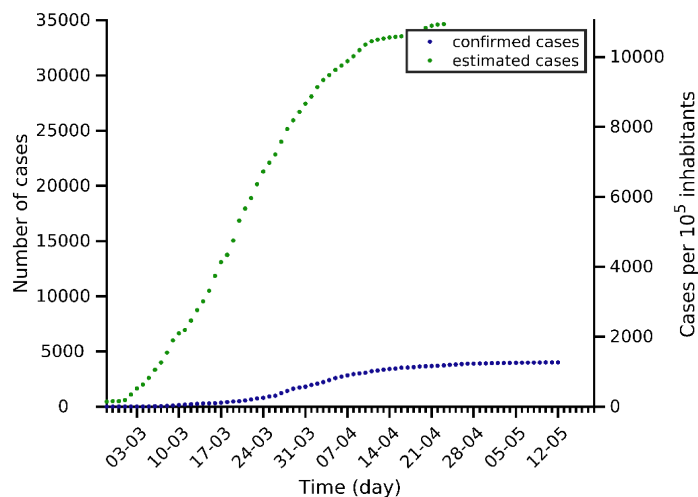
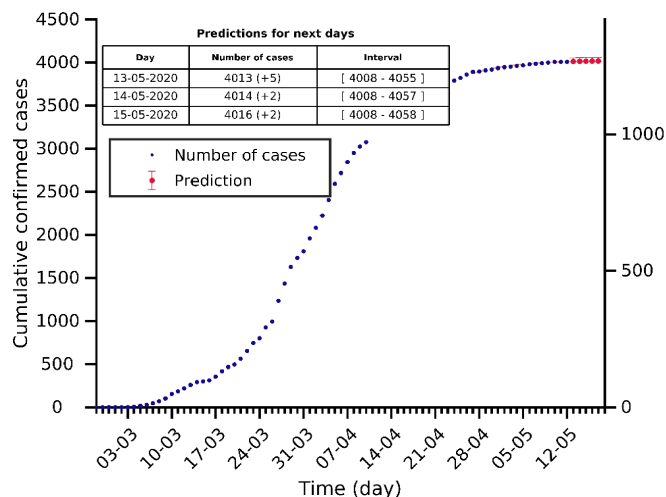
Aragon 12-05-2020. Population: 1.3M. Current cumulated incidence: 406/10⁵



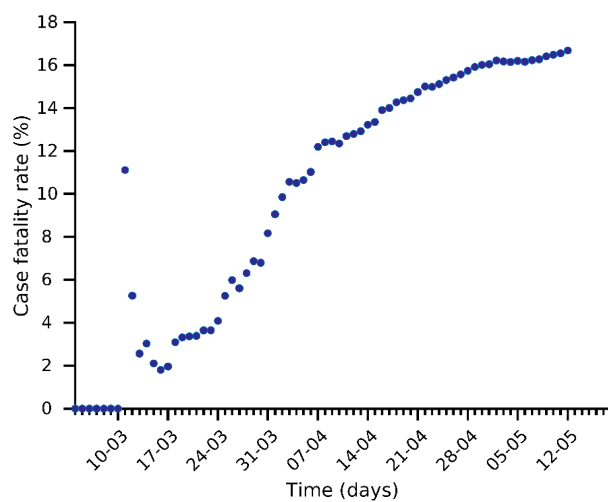
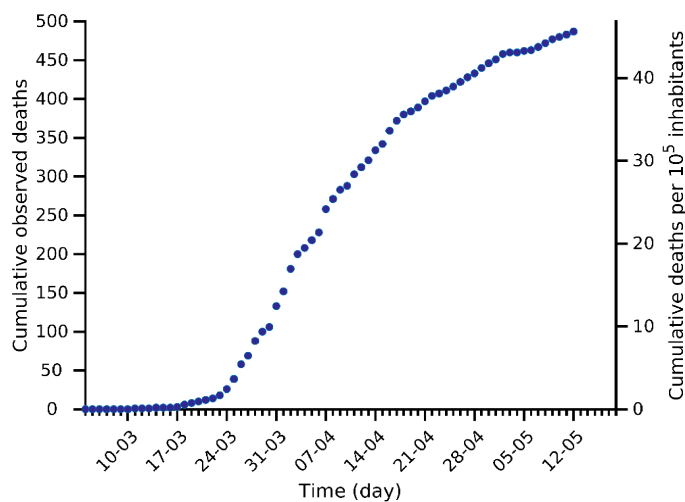
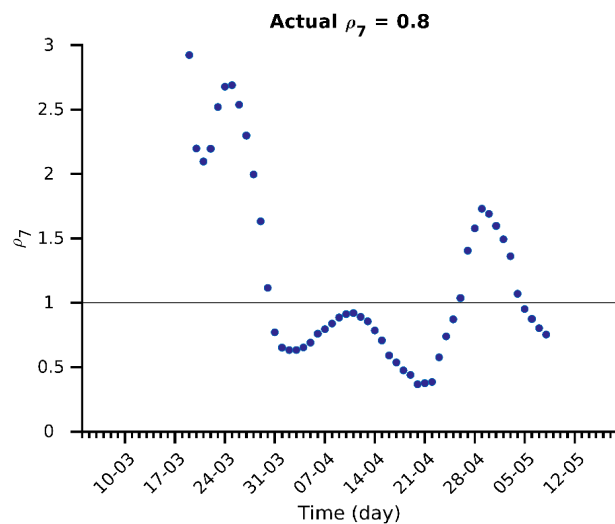
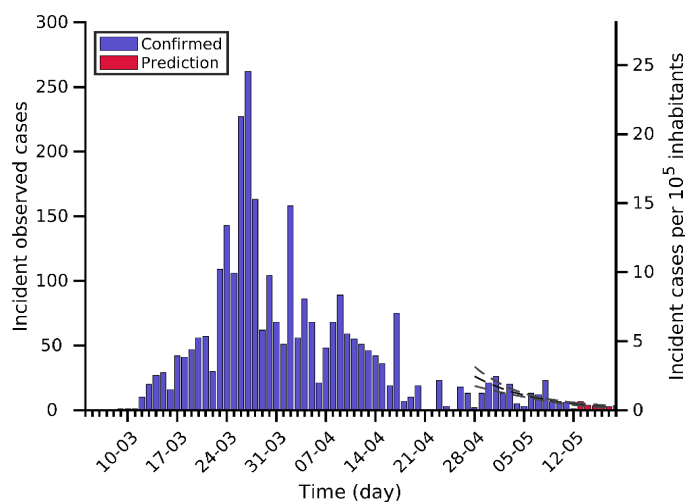
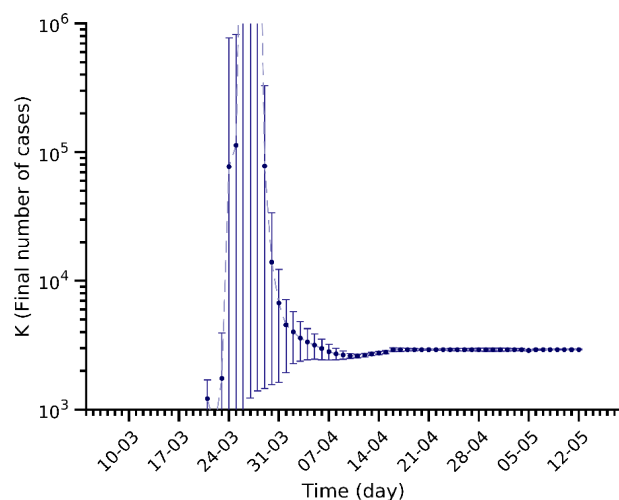
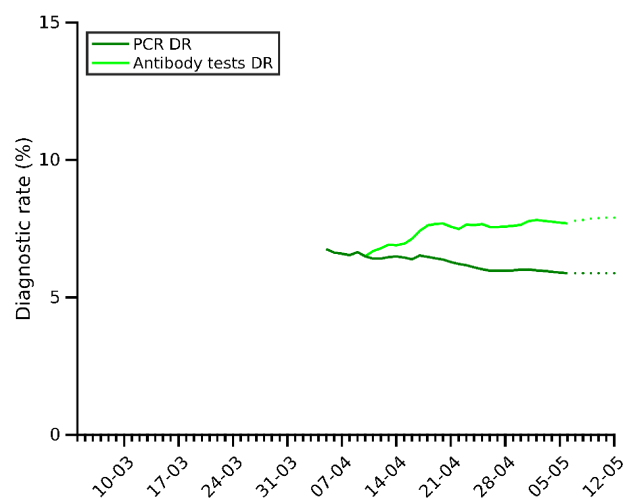
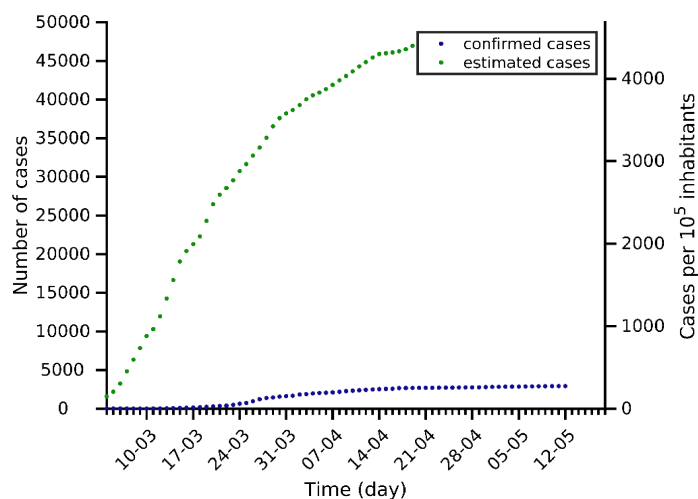
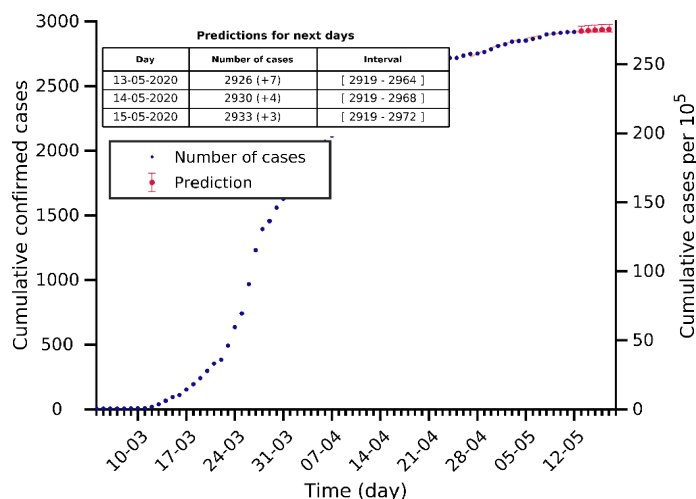
Navarra 12-05-2020. Population: 0.7M. Current cumulated incidence: 777/10⁵



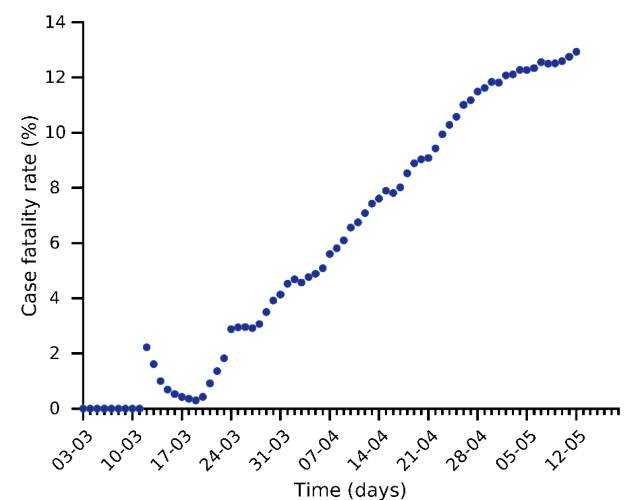
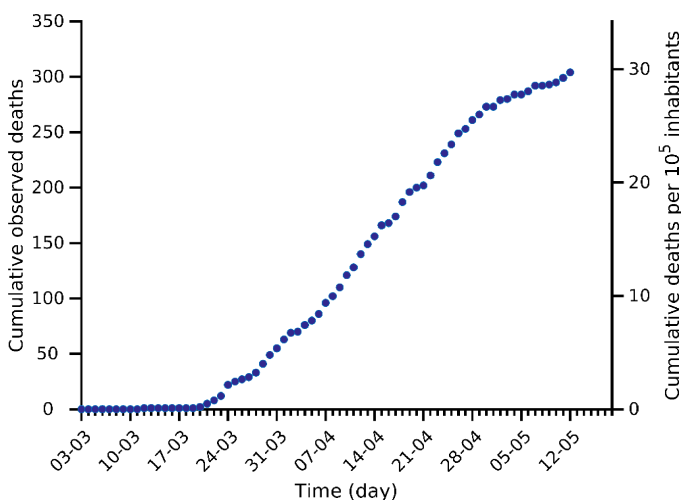
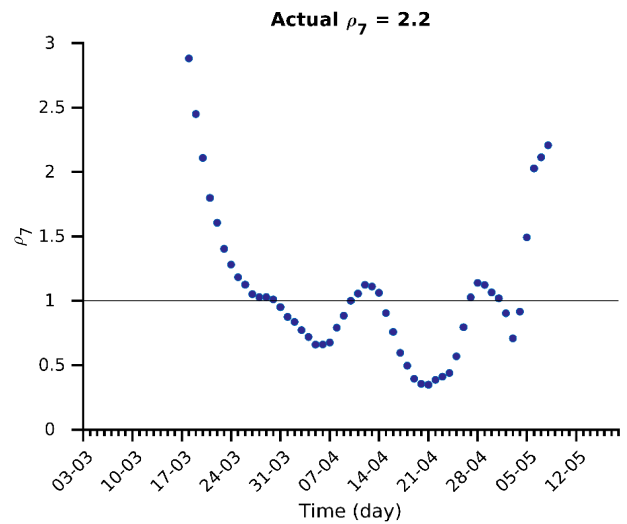
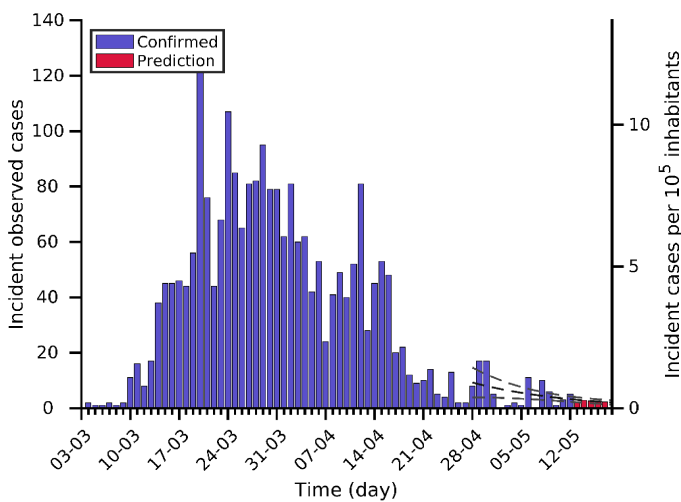
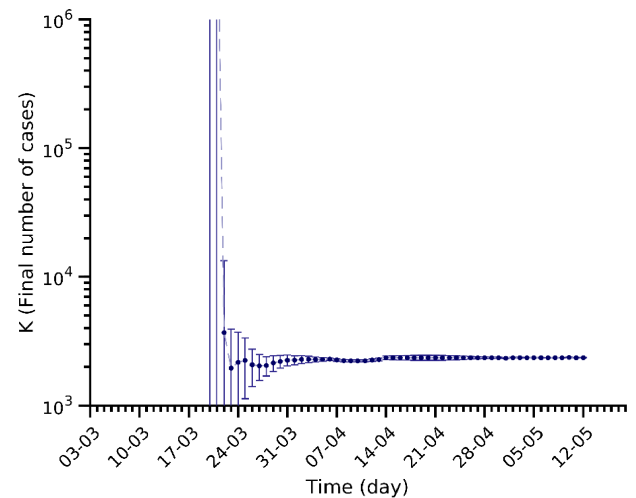
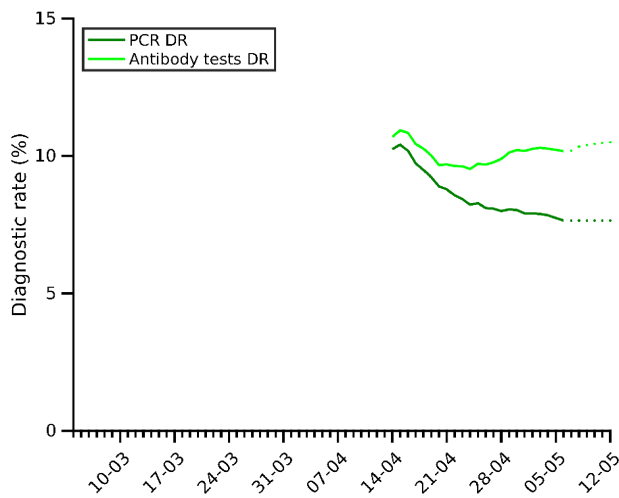
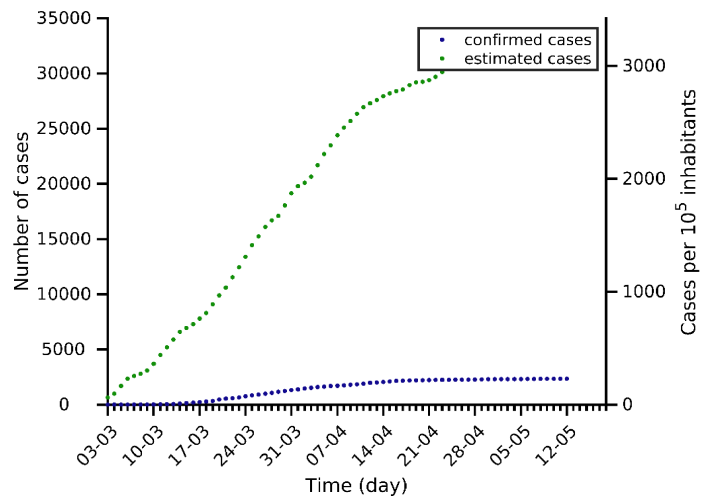
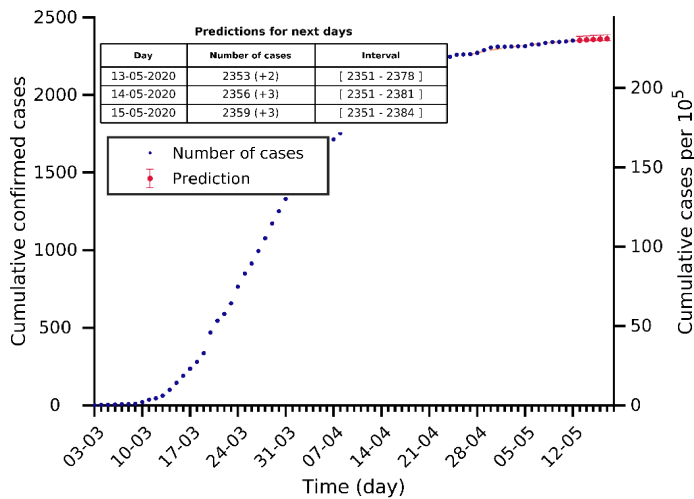
La Rioja 12-05-2020. Population: 0.3M. Current cumulated incidence: 1265/10⁵



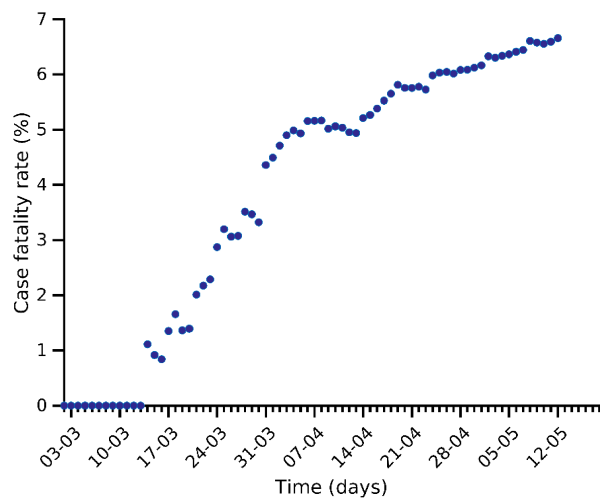
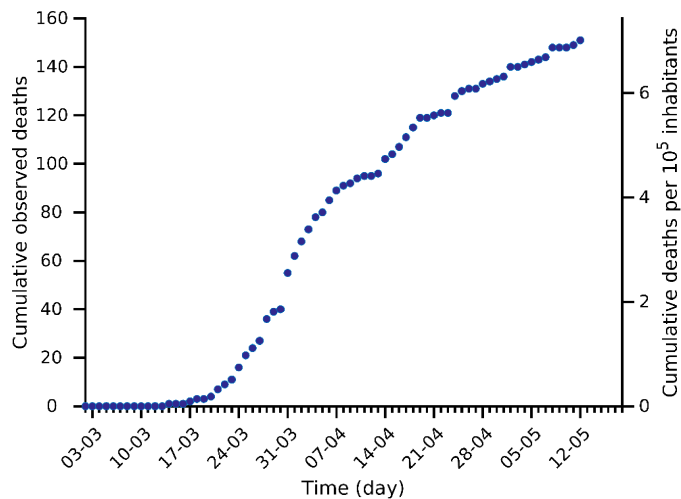
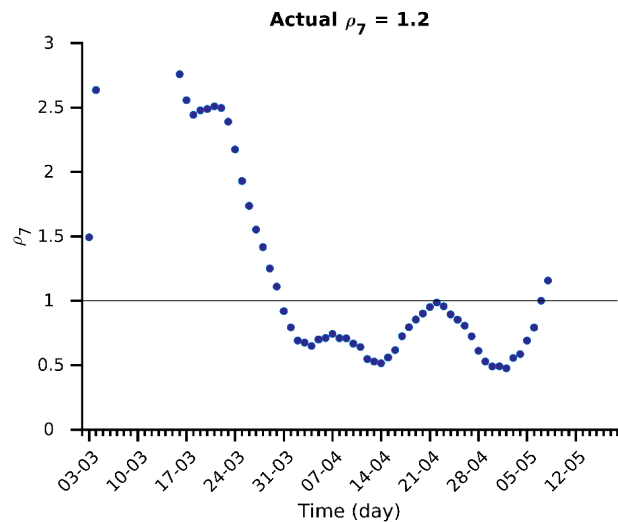
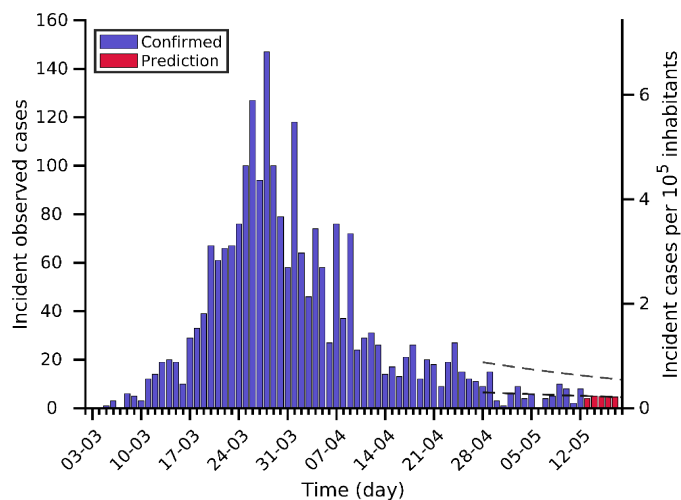
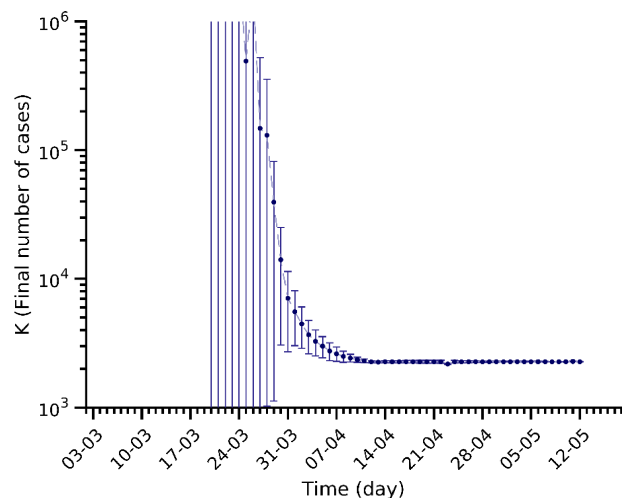
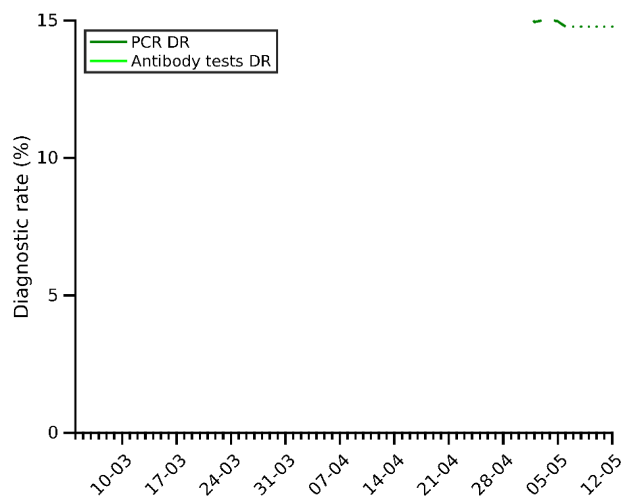
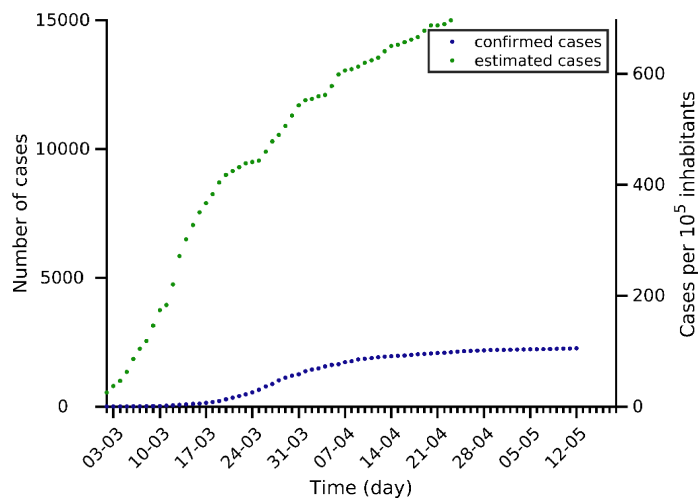
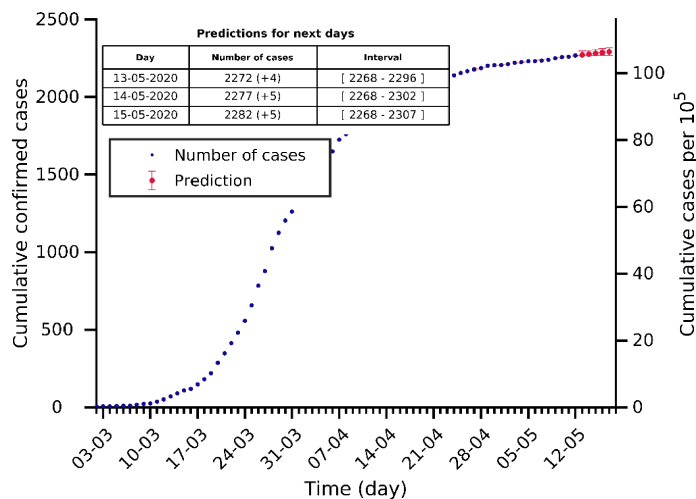
Extremadura 12-05-2020. Population: 1.1M. Current cumulated incidence: 273/10⁵



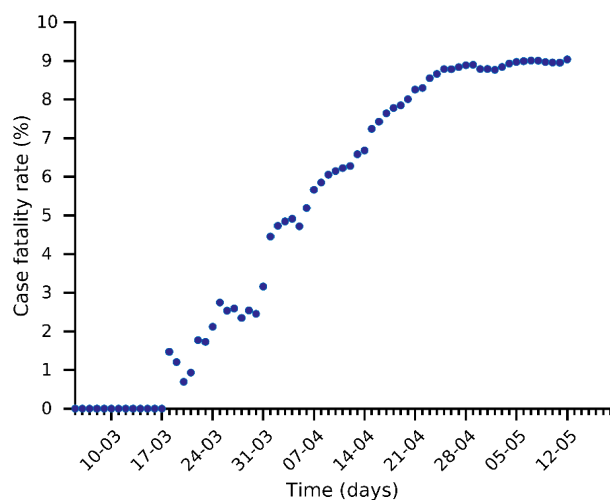
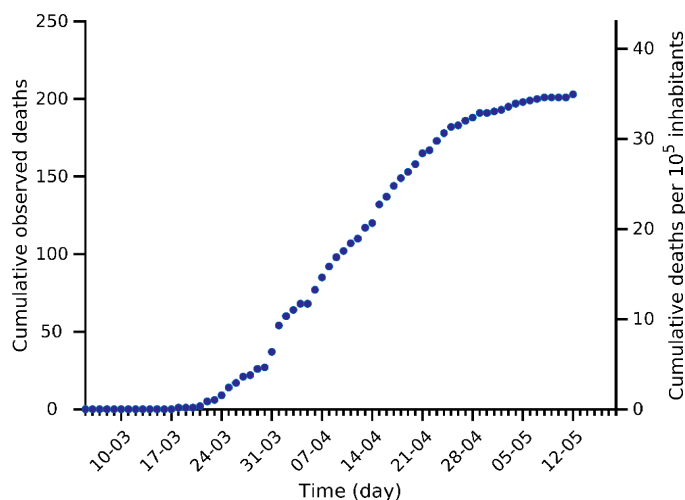
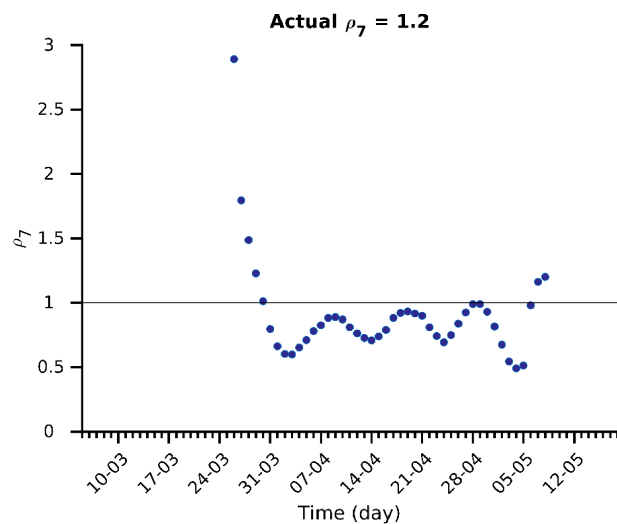
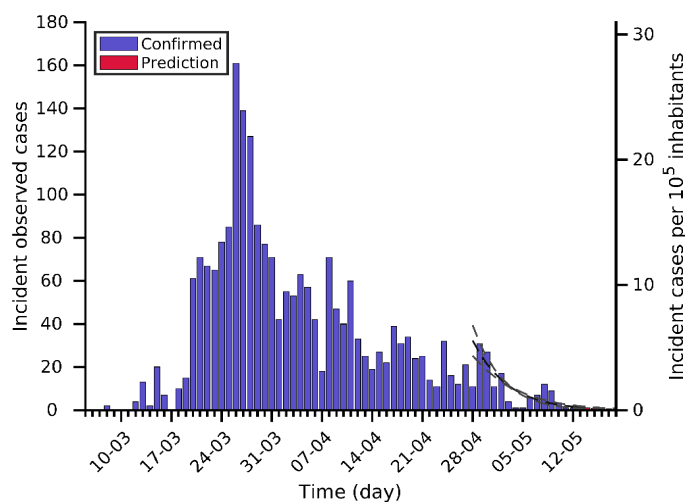
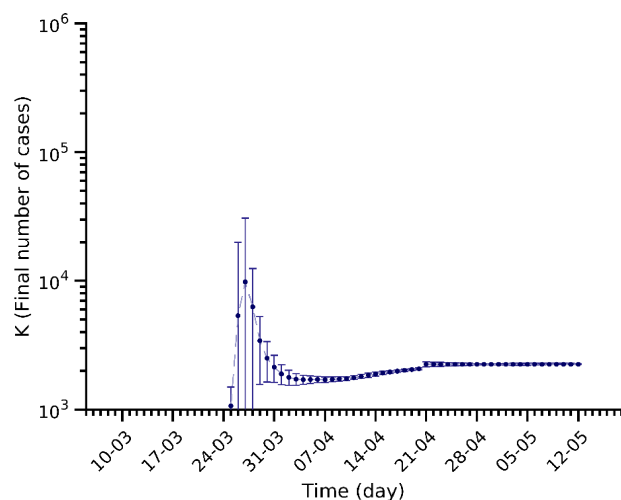
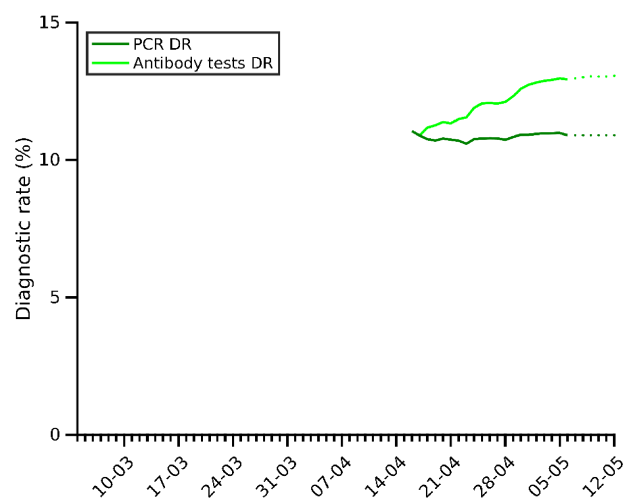
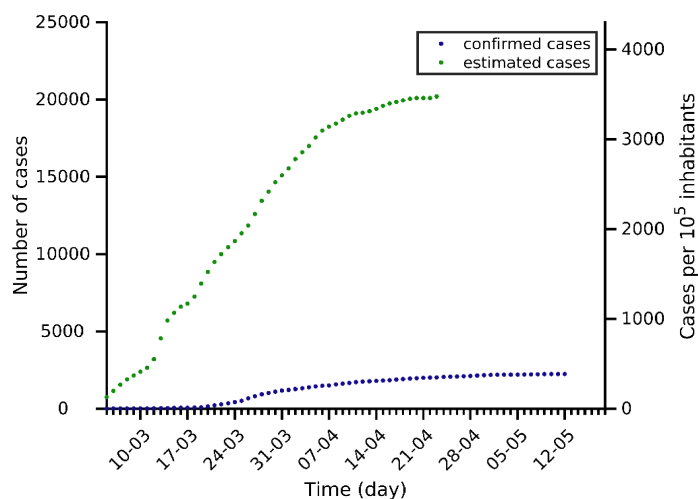
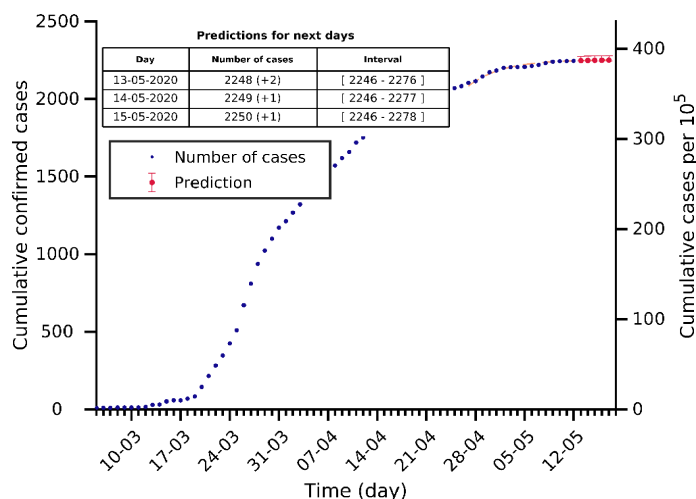
Asturias 12-05-2020. Population: 1.0M. Current cumulated incidence: 230/10⁵



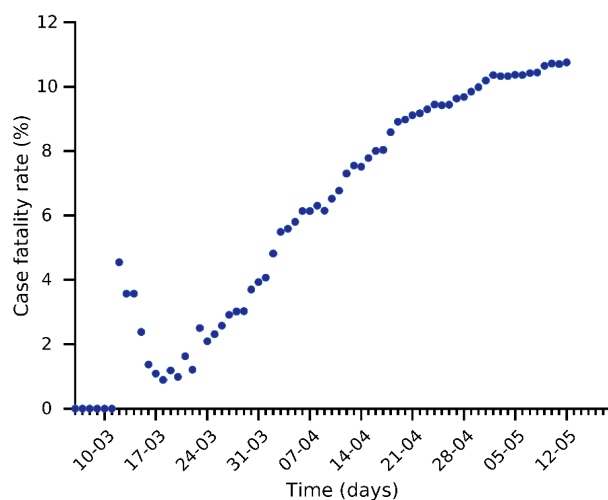
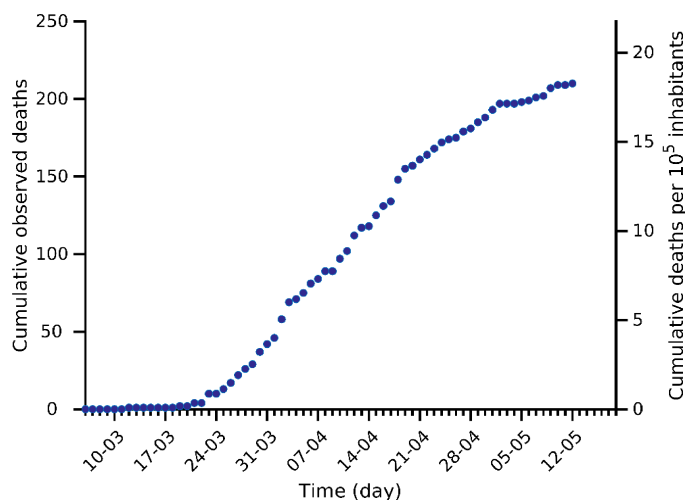
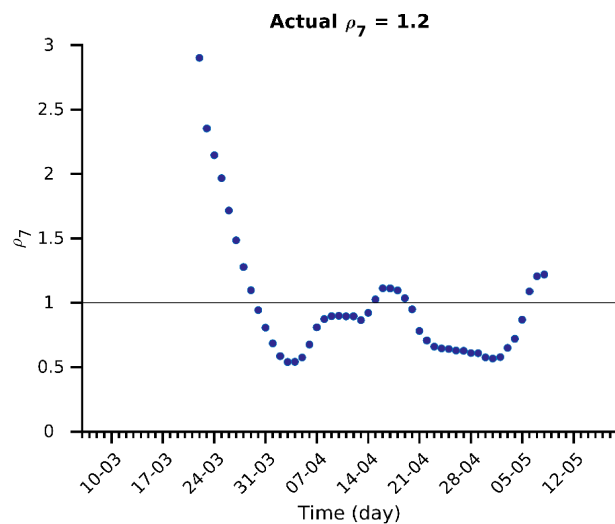
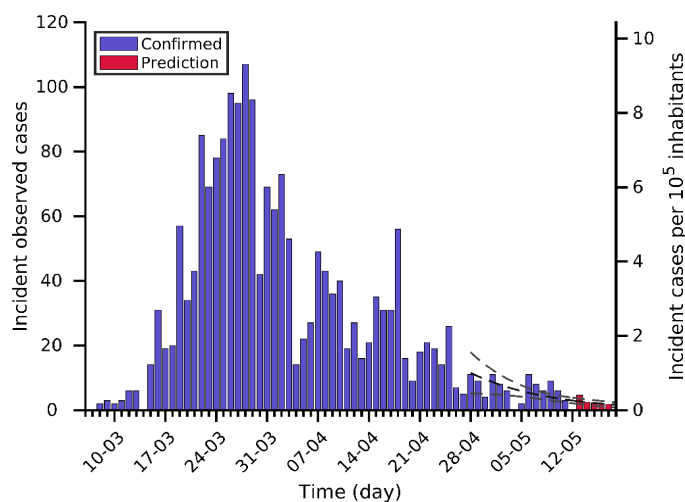
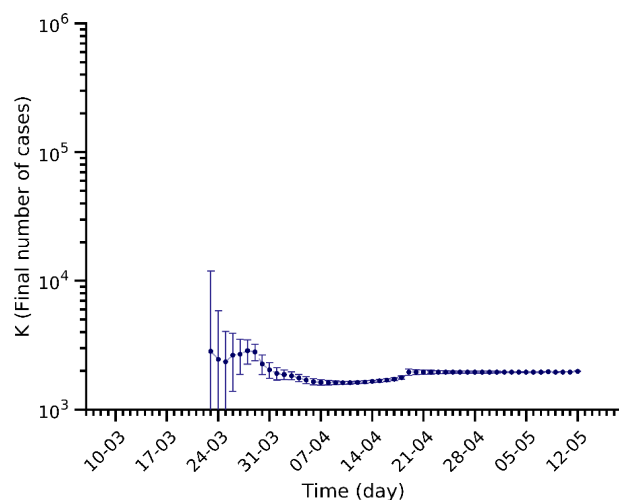
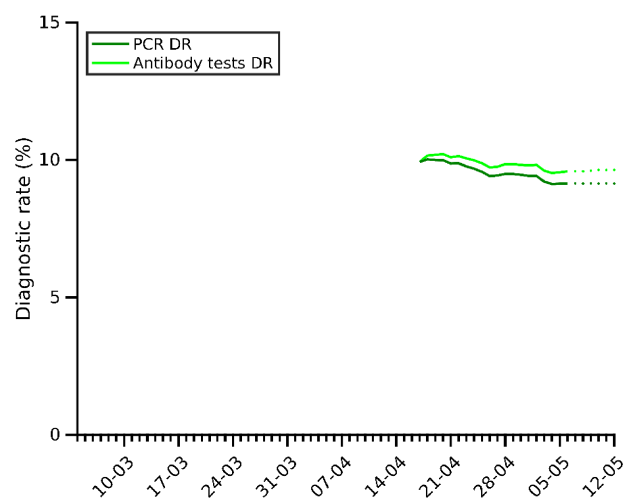
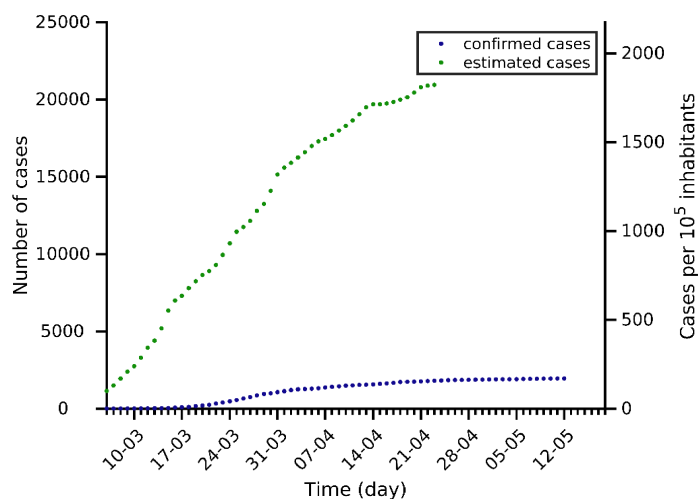
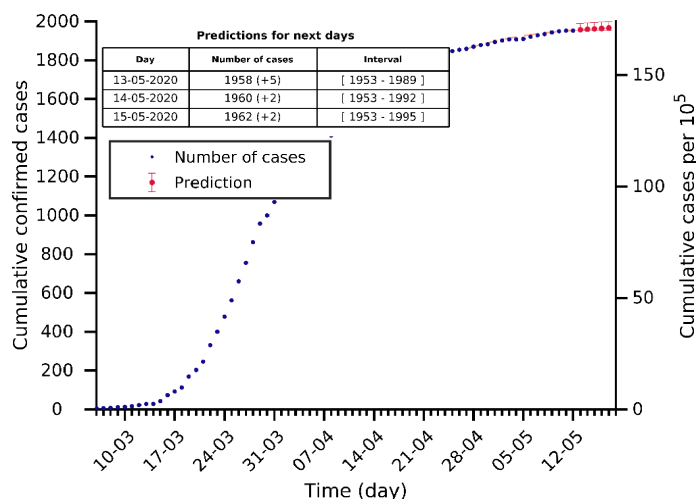
Canarias 12-05-2020. Population: 2.2M. Current cumulated incidence: 105/10⁵



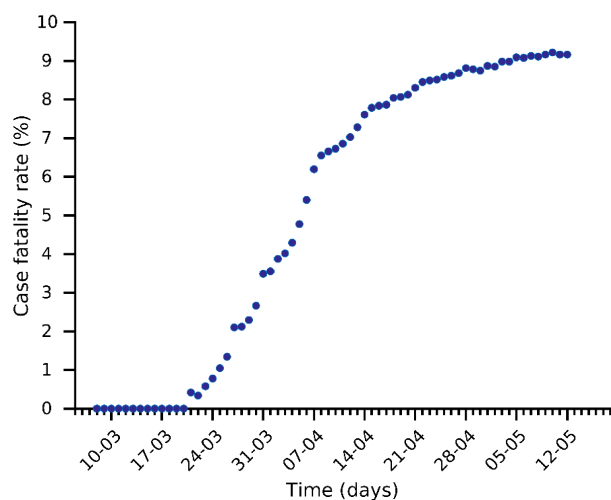
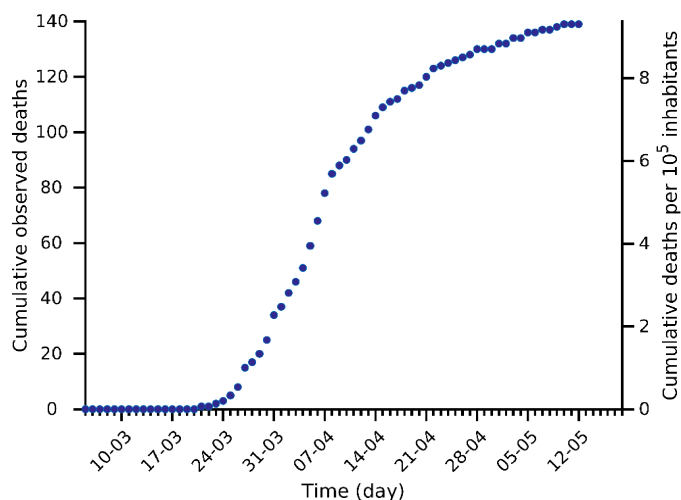
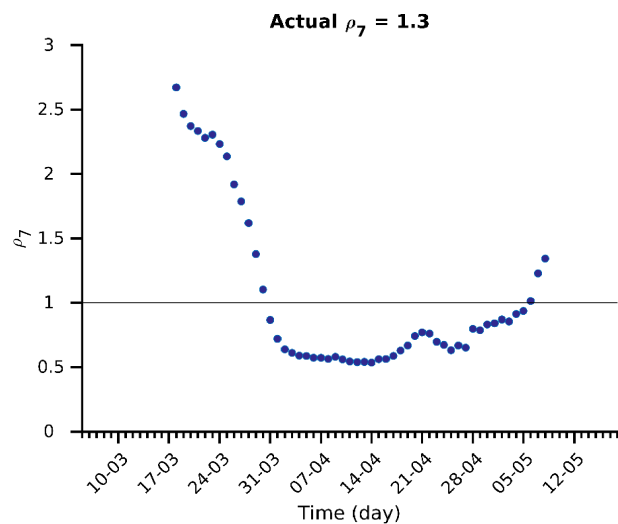
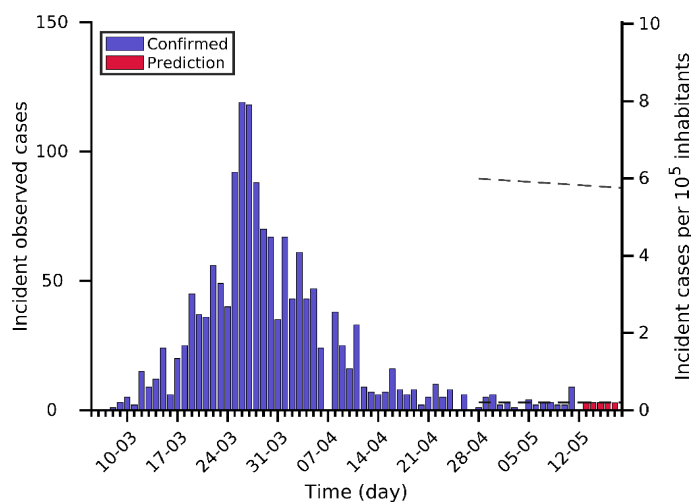
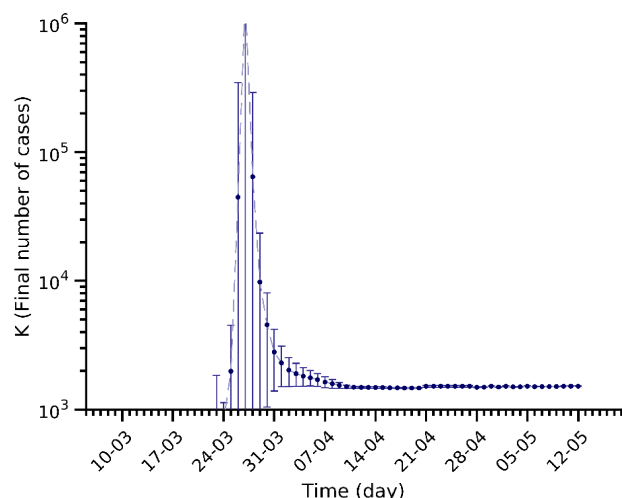
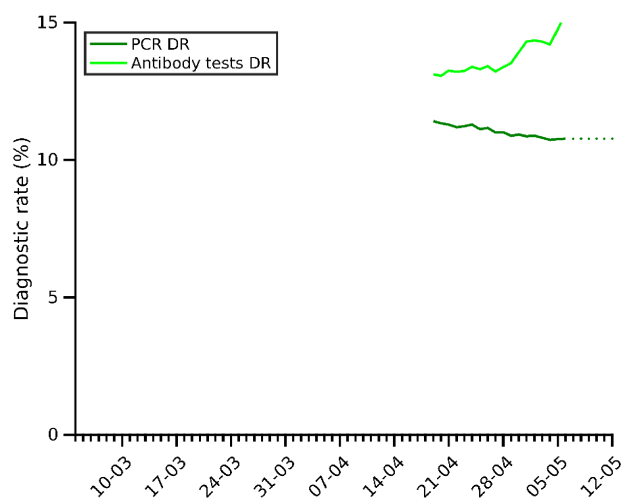
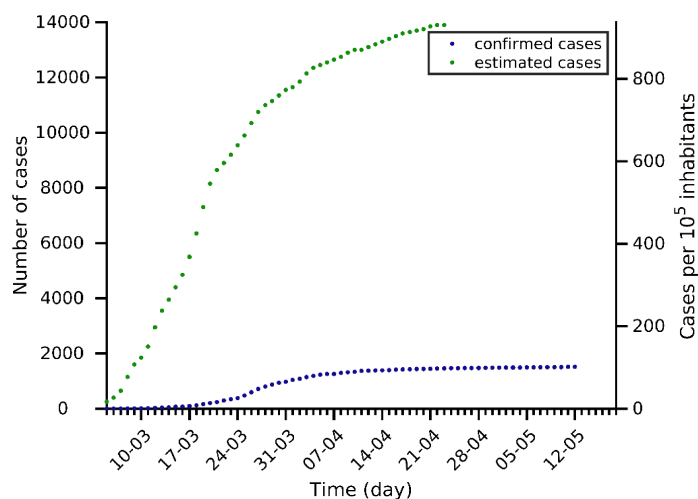
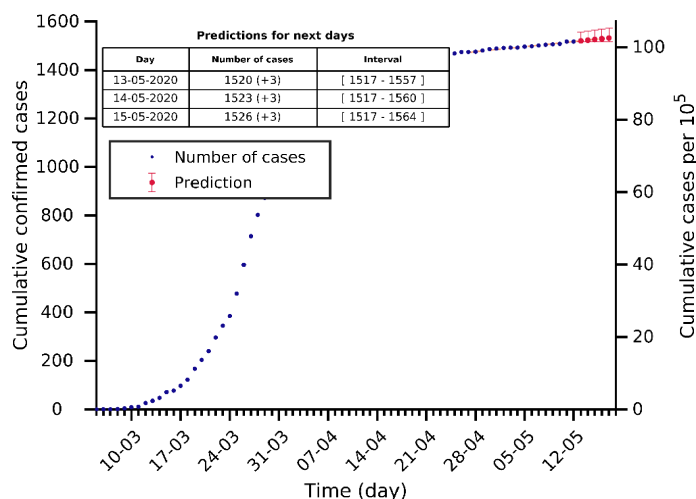
Cantabria 12-05-2020. Population: 0.6M. Current cumulated incidence: 387/10⁵



Baleares 12-05-2020. Population: 1.1M. Current cumulated incidence: 170/10⁵



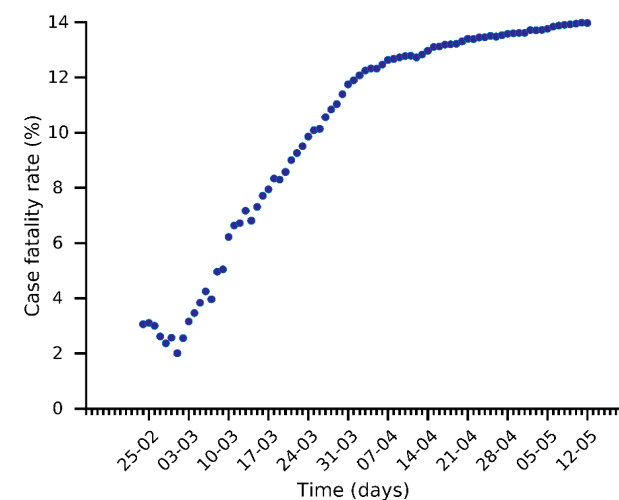
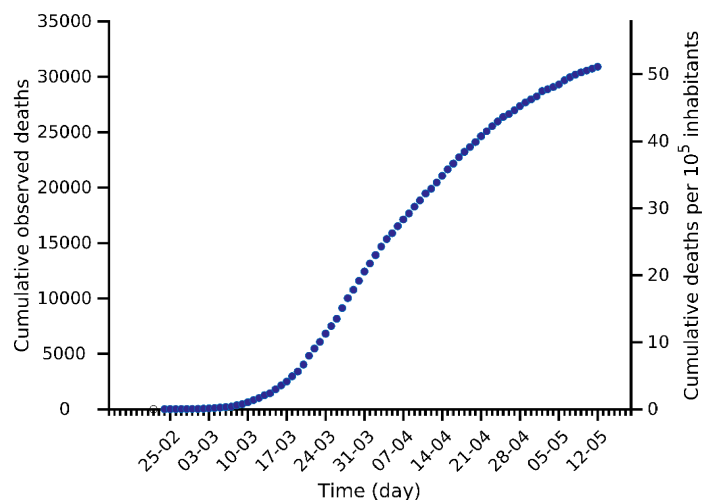
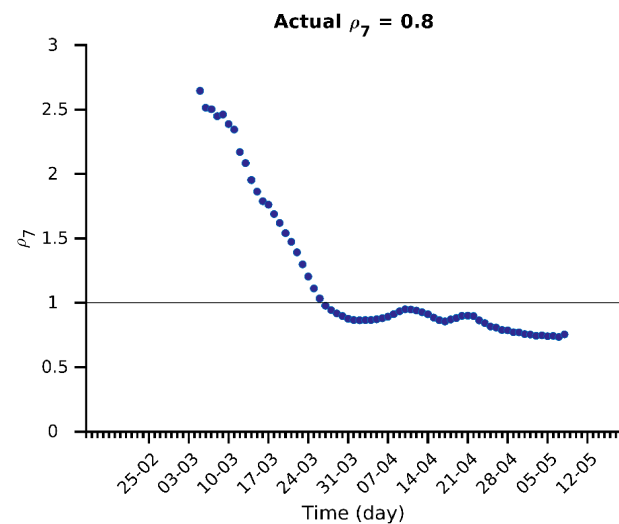
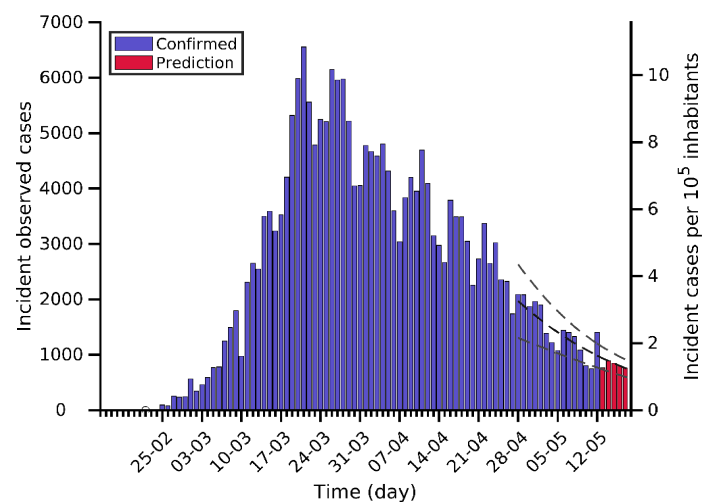
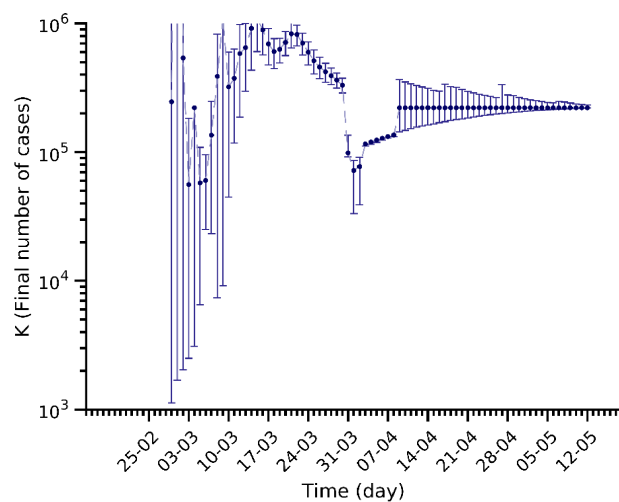
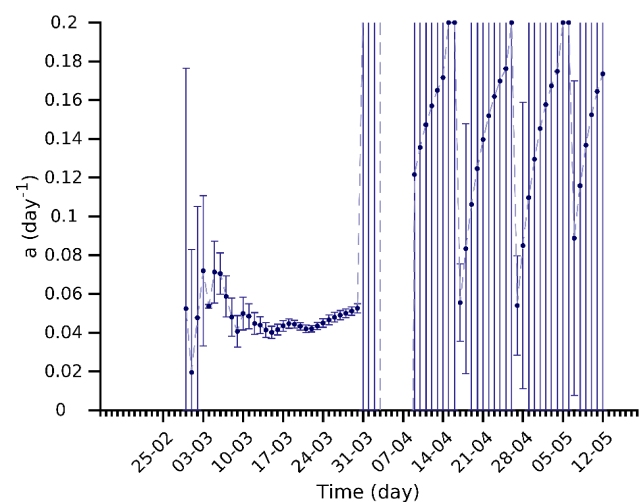
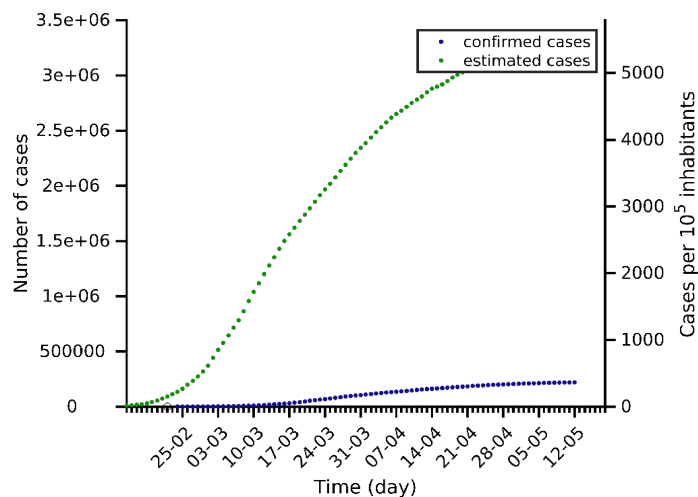
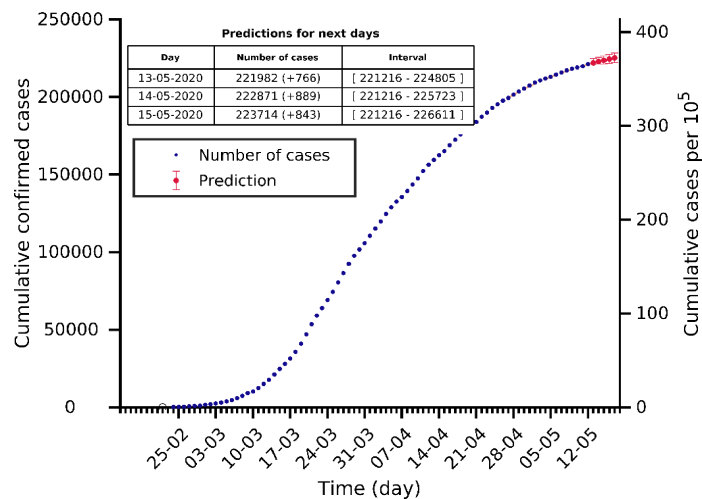
Murcia 12-05-2020. Population: 1.5M. Current cumulated incidence: 102/10⁵



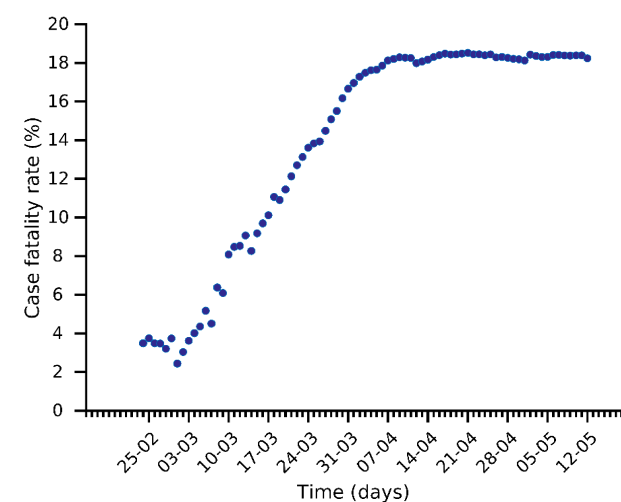
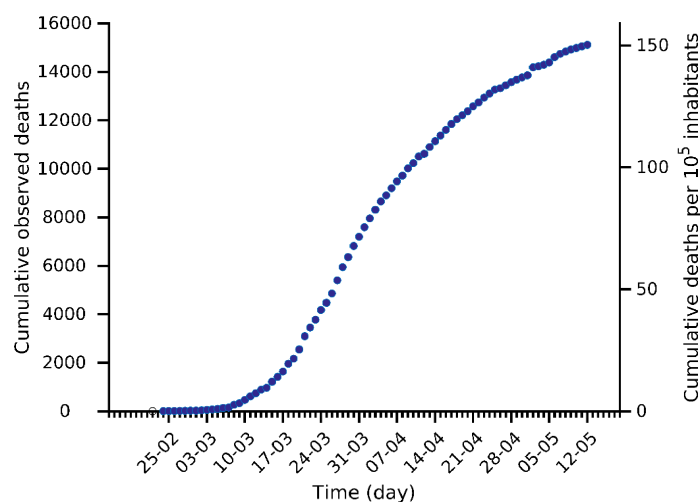
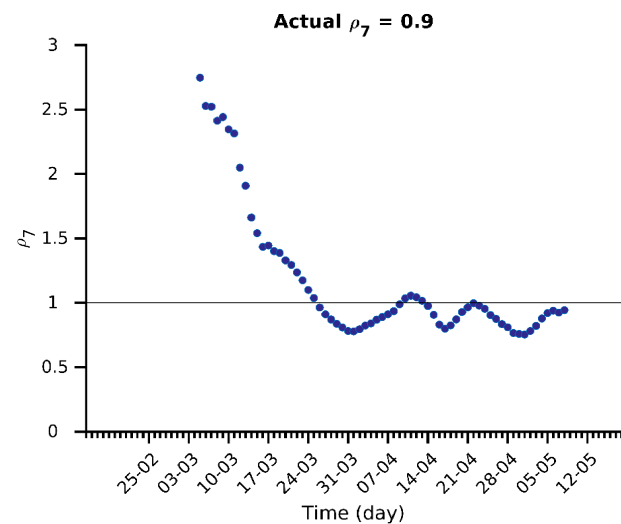
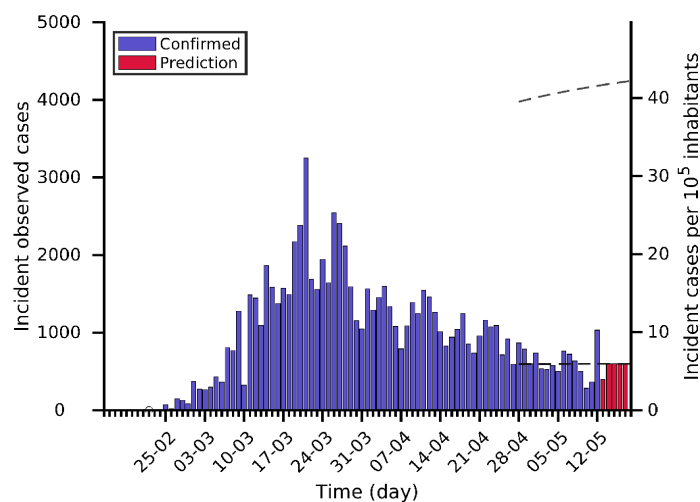
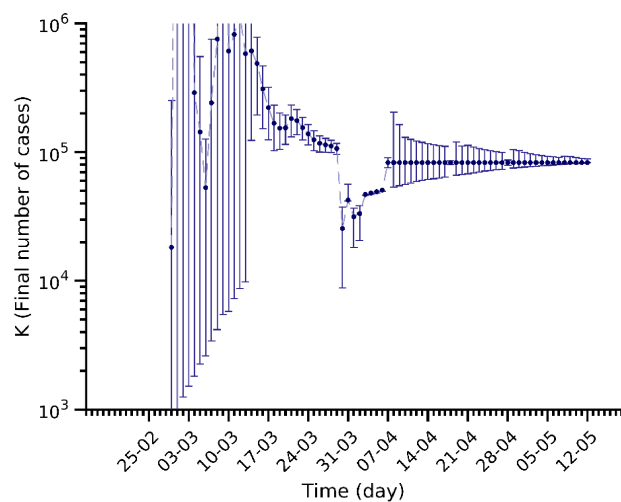
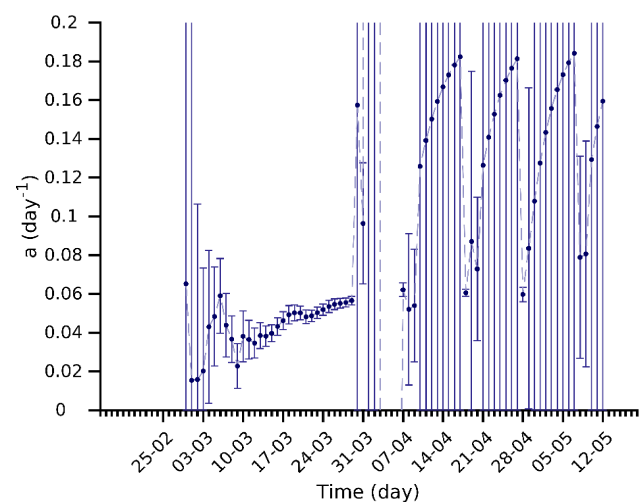
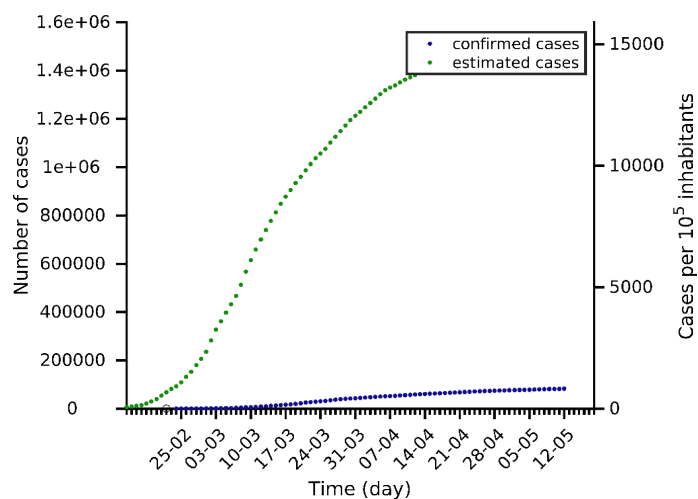
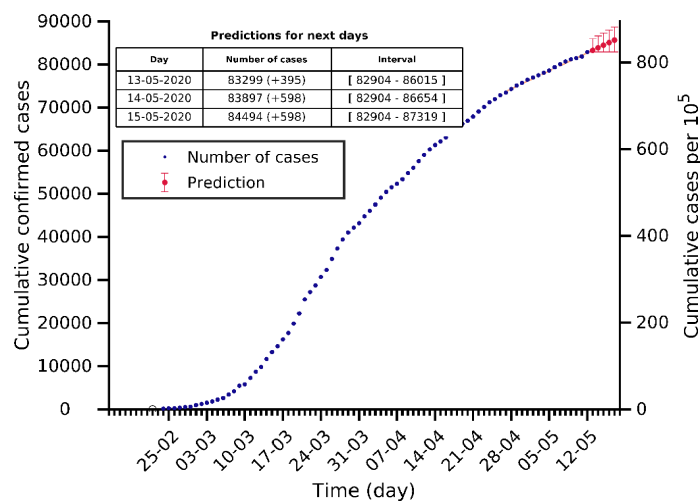
(4) Analysis and prediction of COVID-19 for Italy and its regions

Data obtained from: <https://github.com/pcm-dpc/COVID-19/tree/master/dati-andamento-nazionale>

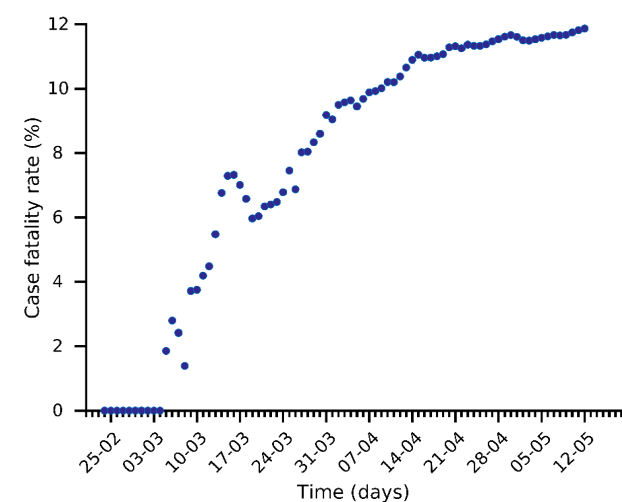
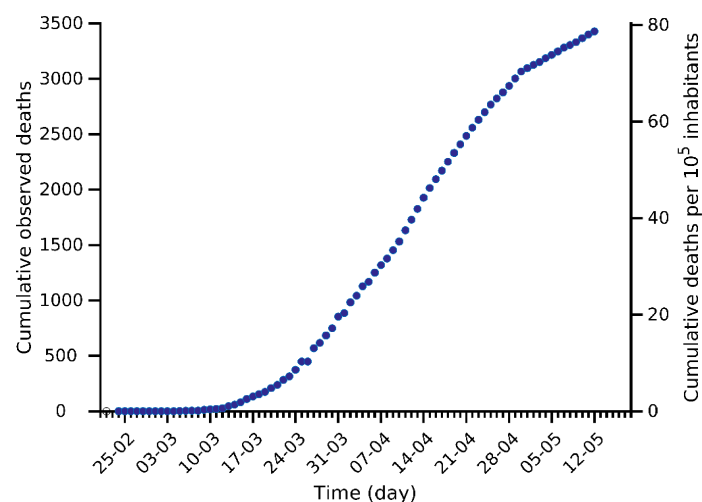
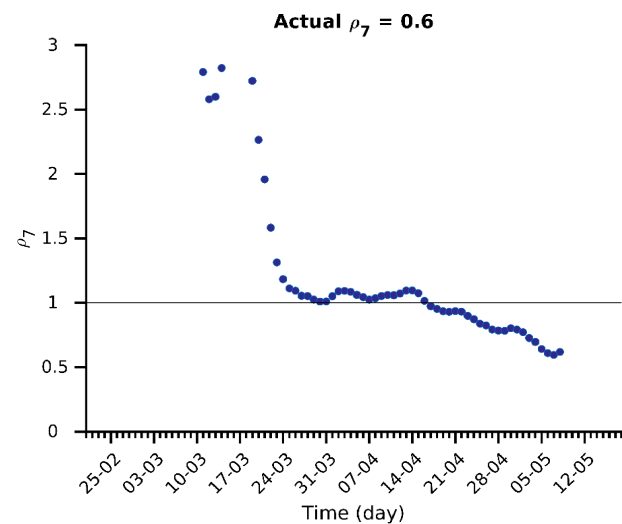
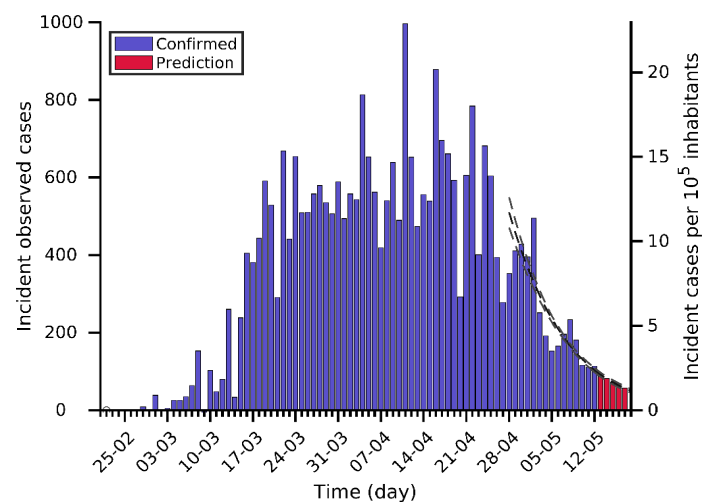
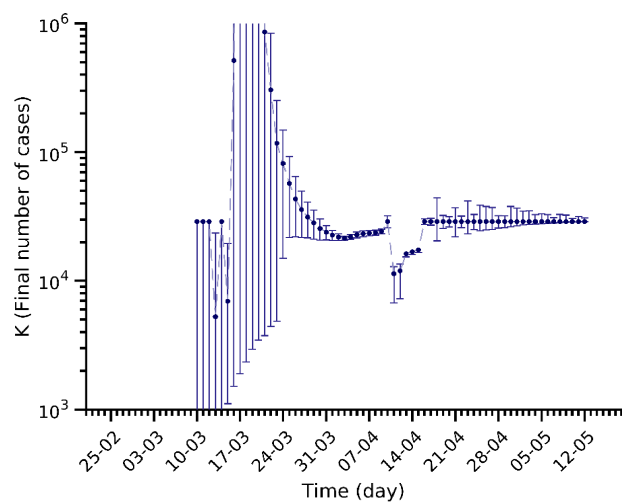
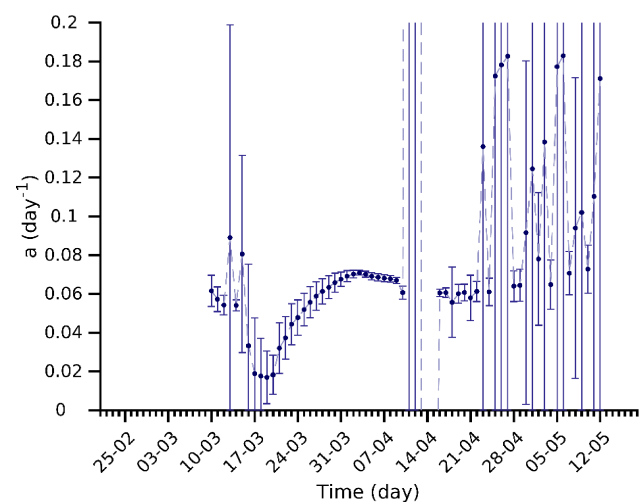
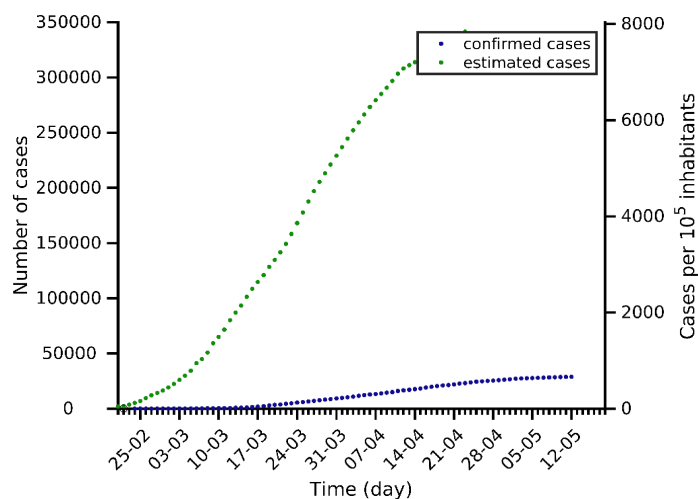
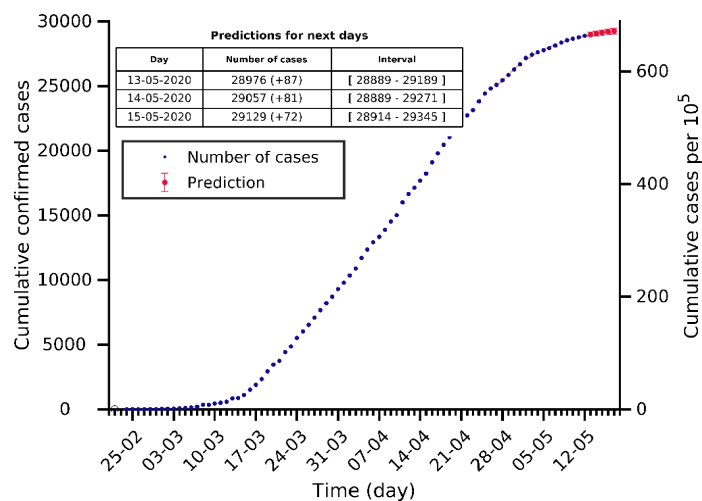
Italy 12-05-2020. Population: 60.5M. Current cumulated incidence: 366/10⁵



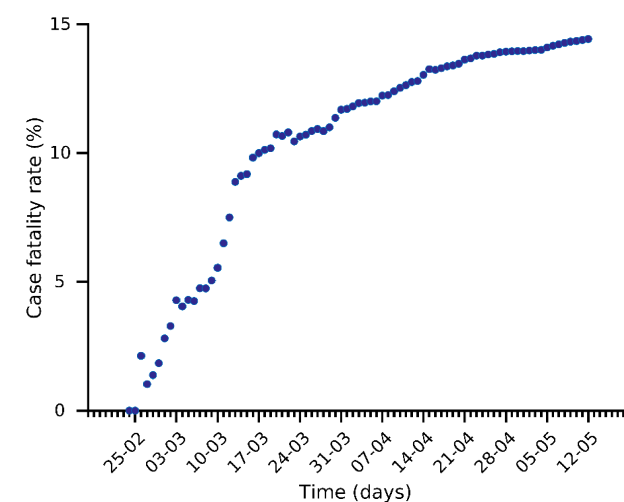
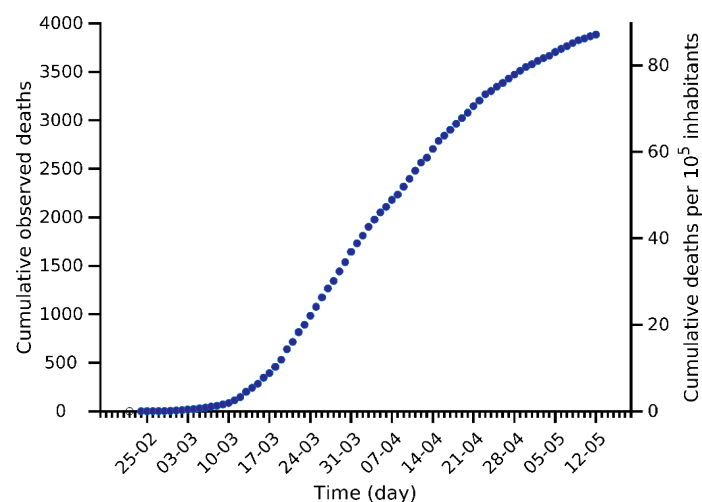
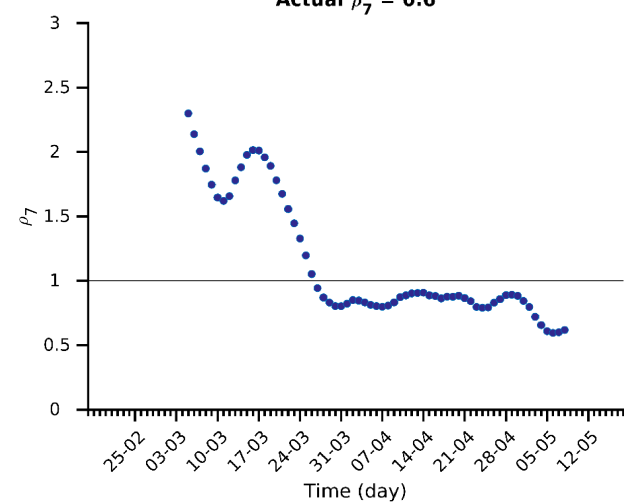
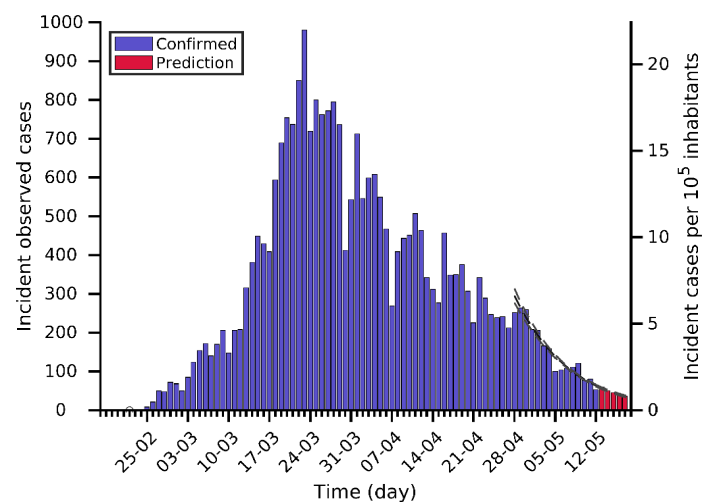
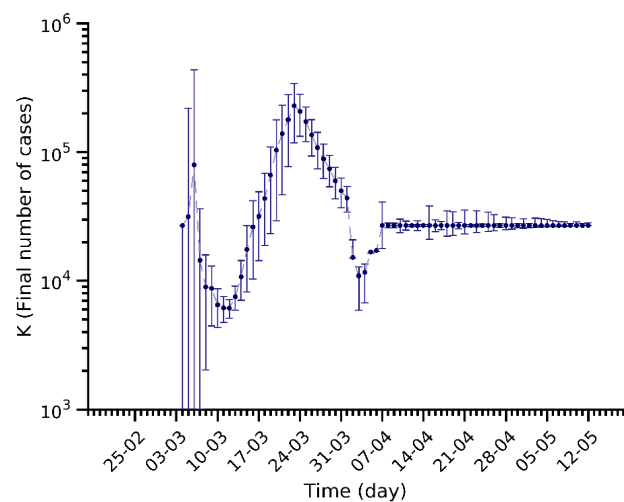
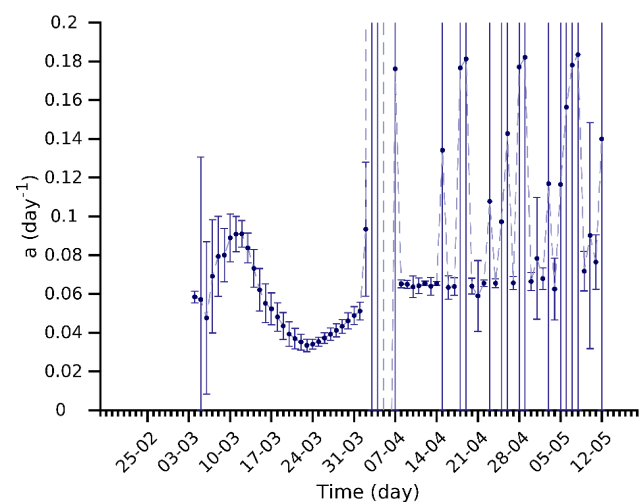
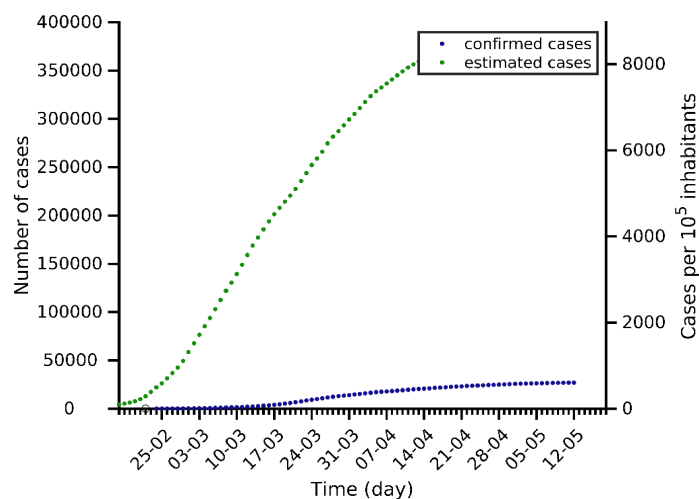
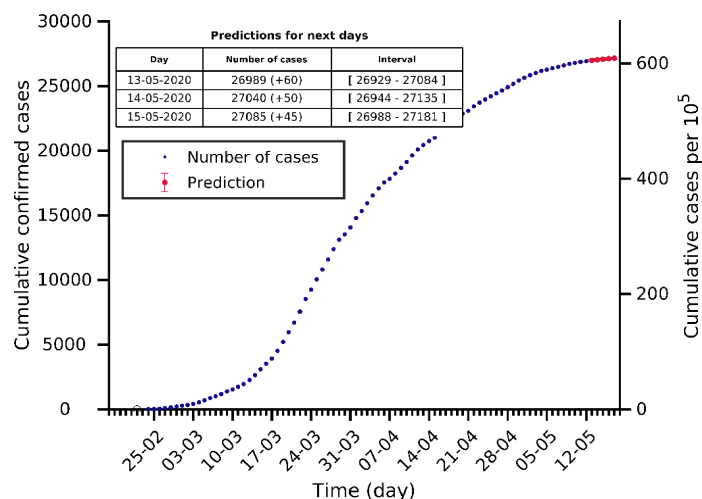
Lombardia 12-05-2020. Population: 10.1M. Current cumulated incidence: 824/10⁵



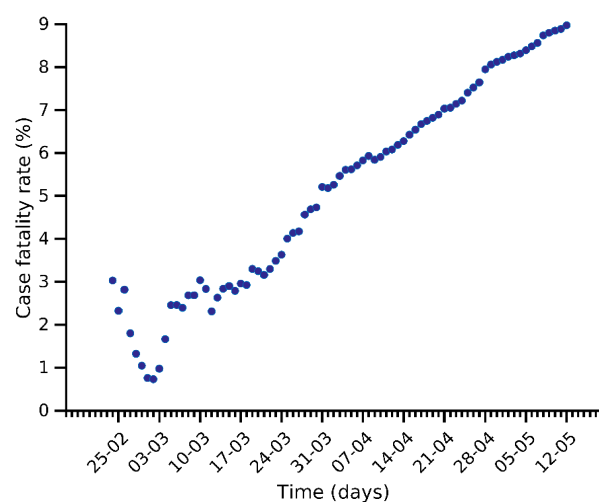
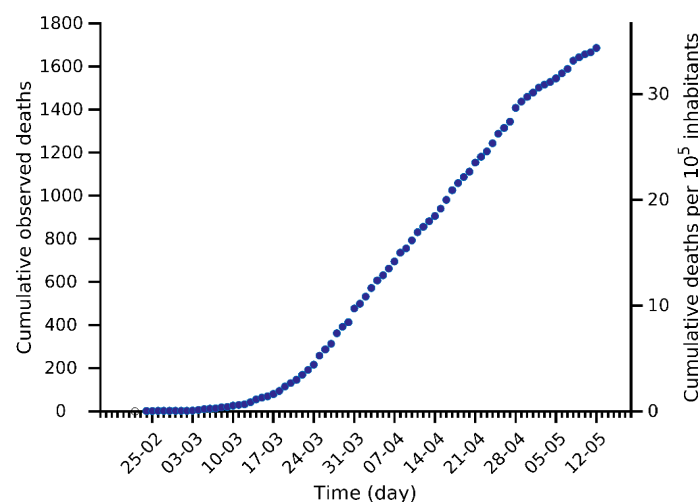
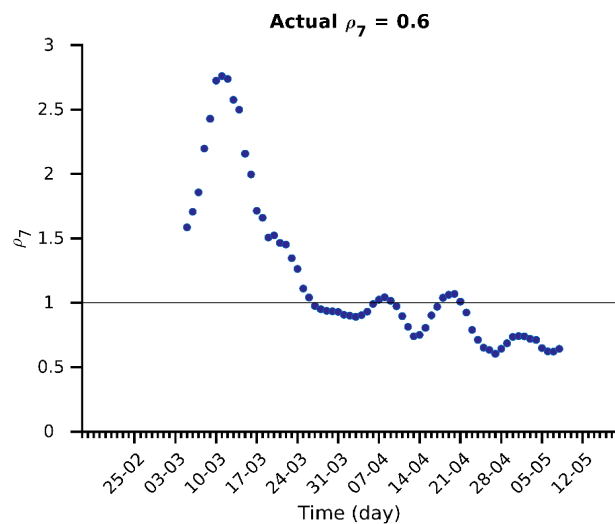
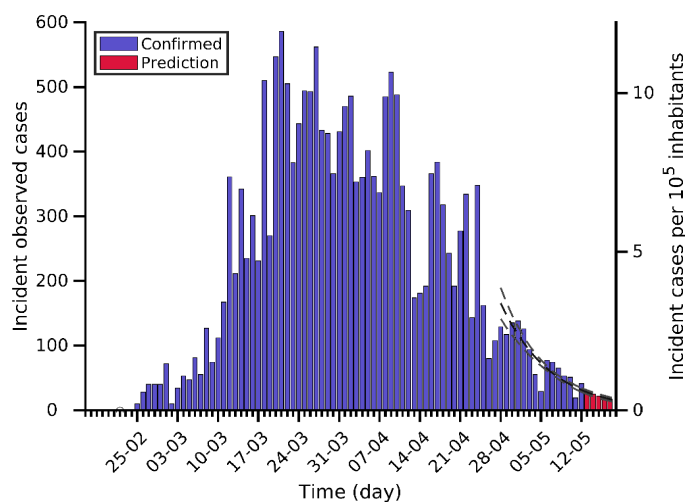
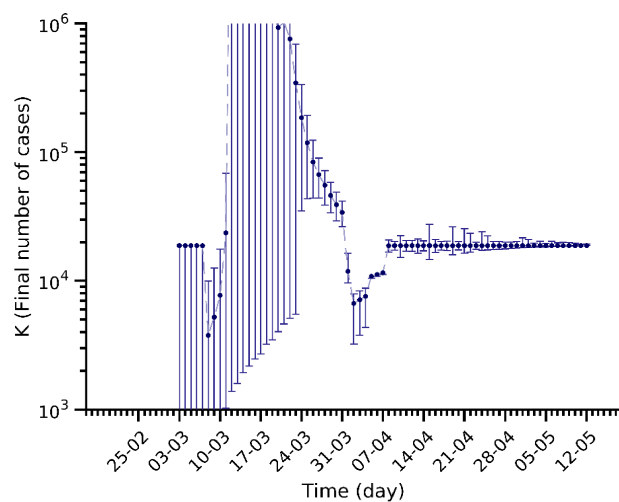
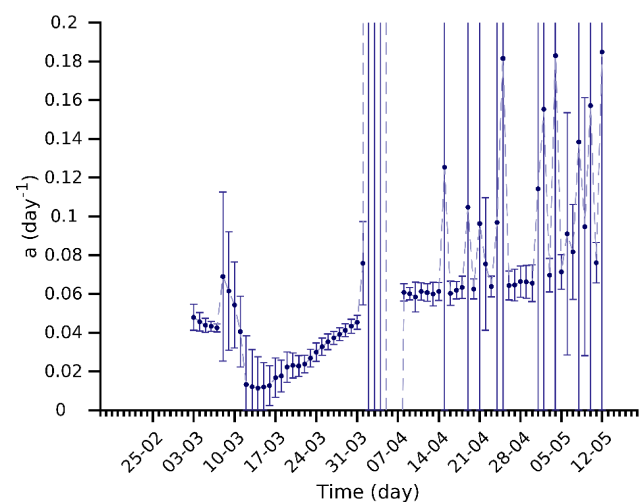
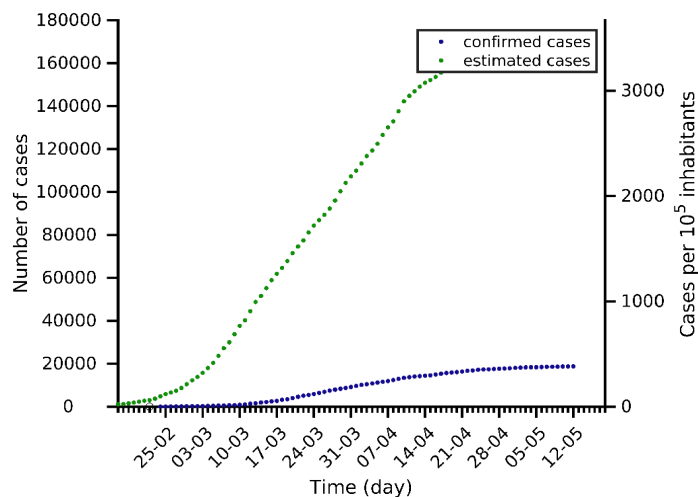
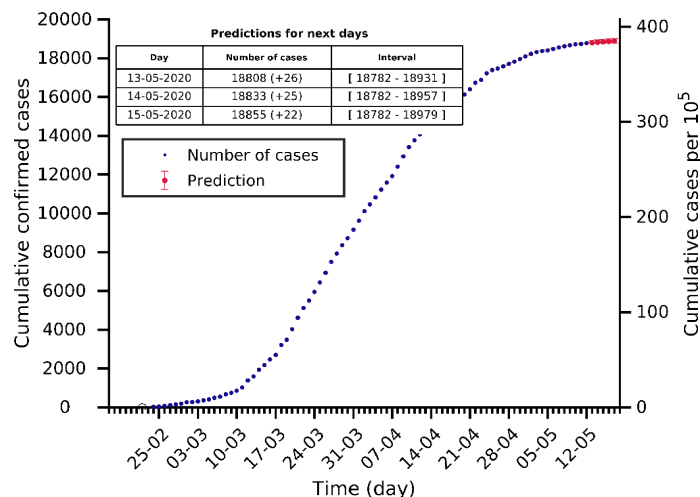
Piemonte 12-05-2020. Population: 4.4M. Current cumulated incidence: 663/10⁵



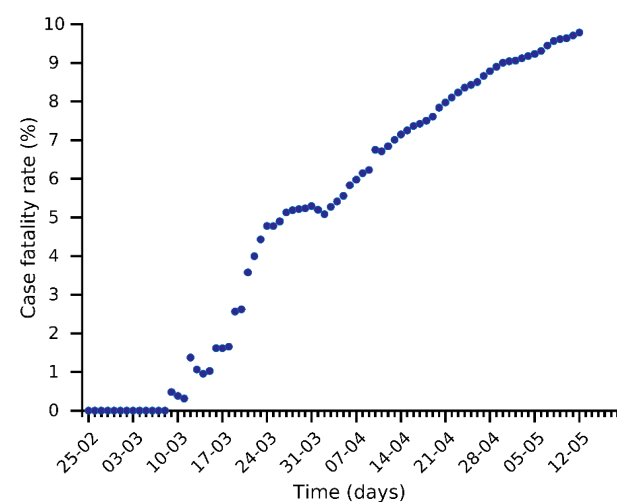
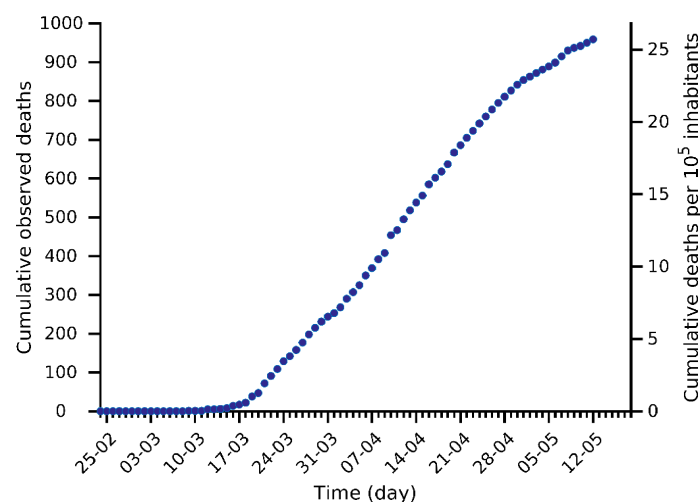
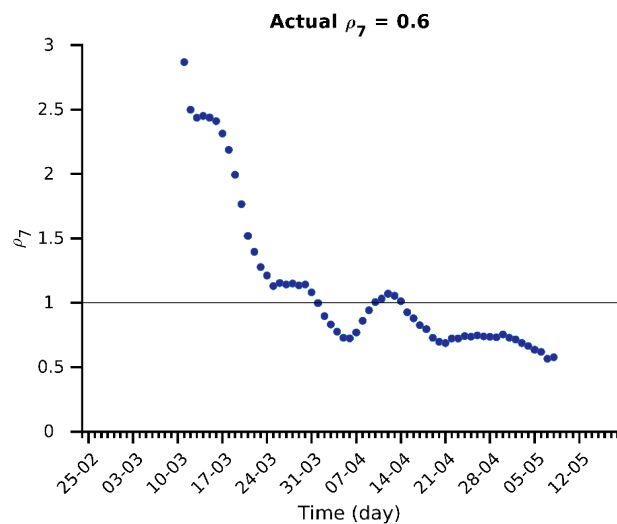
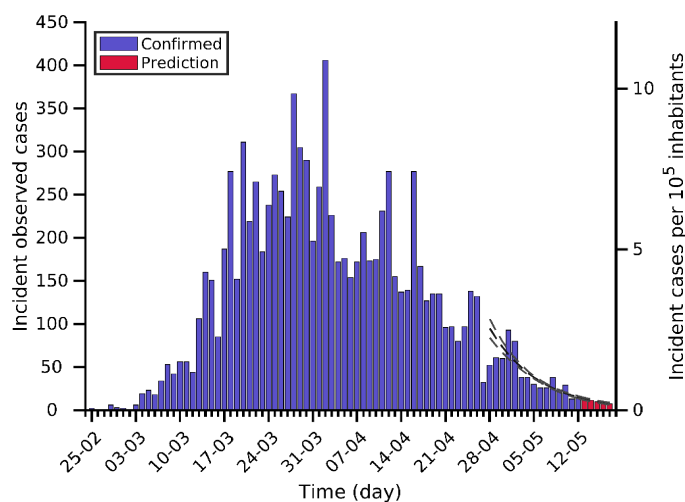
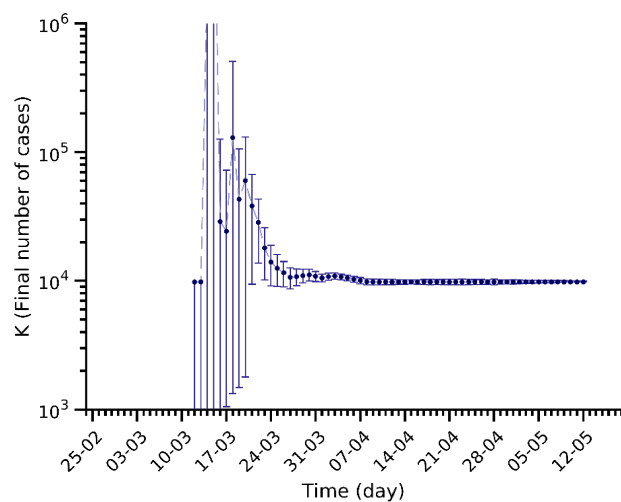
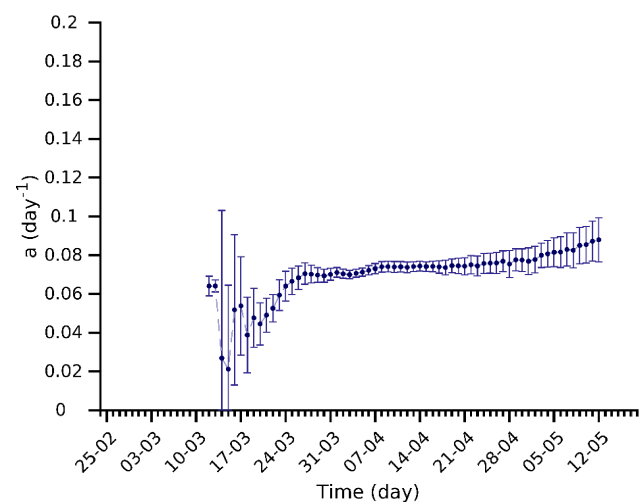
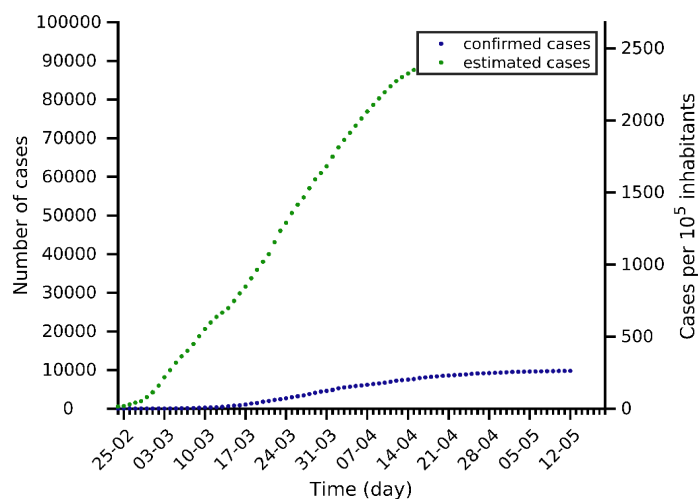
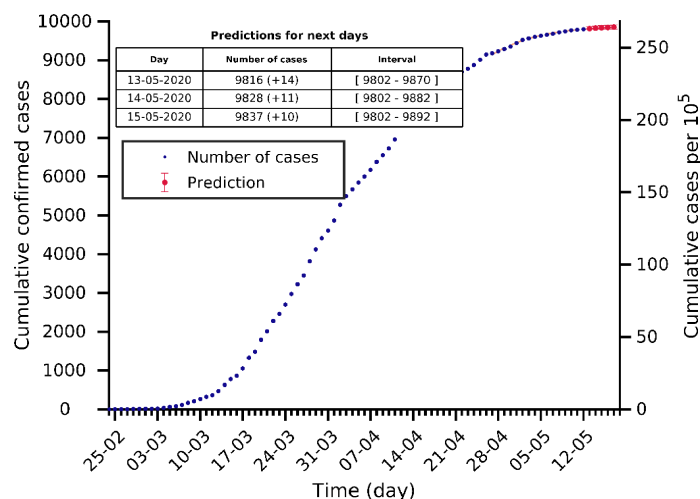
Emilia Romagna 12-05-2020. Population: 4.5M. Current cumulated incidence: 604/10⁵



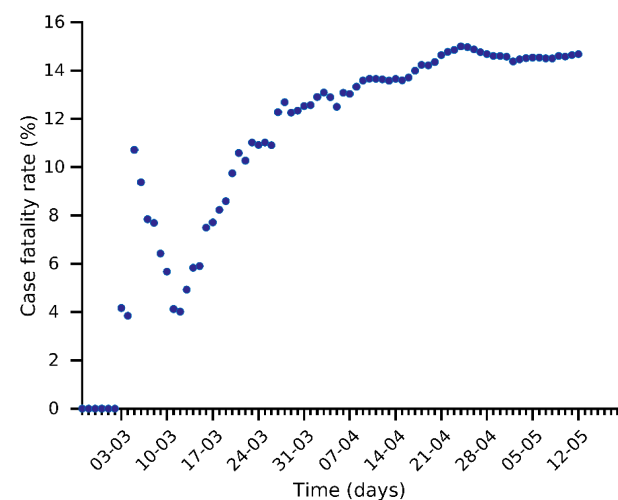
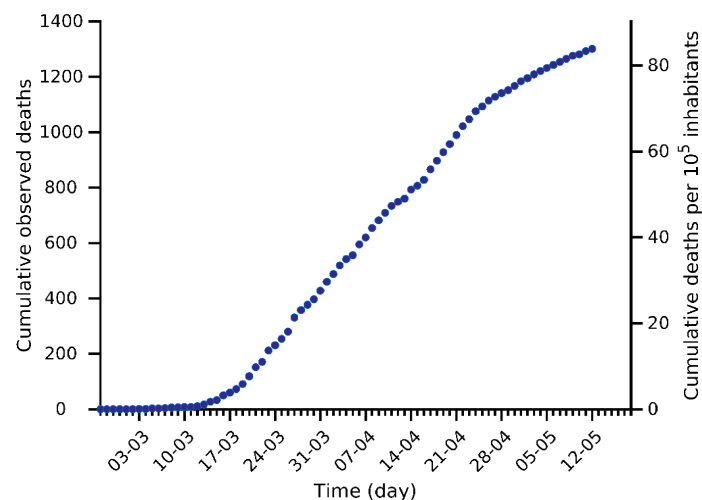
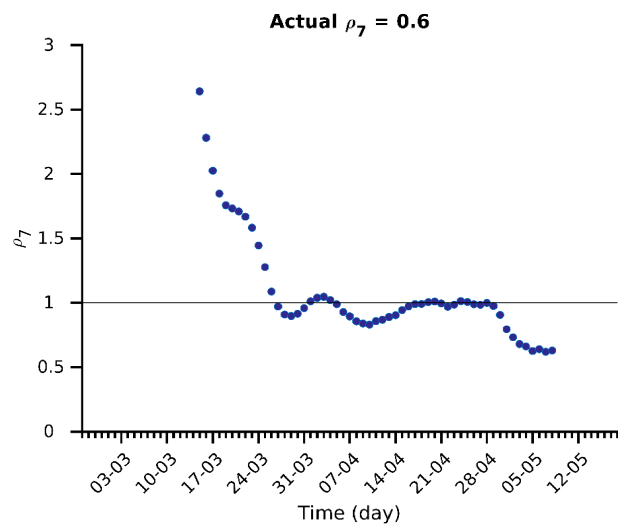
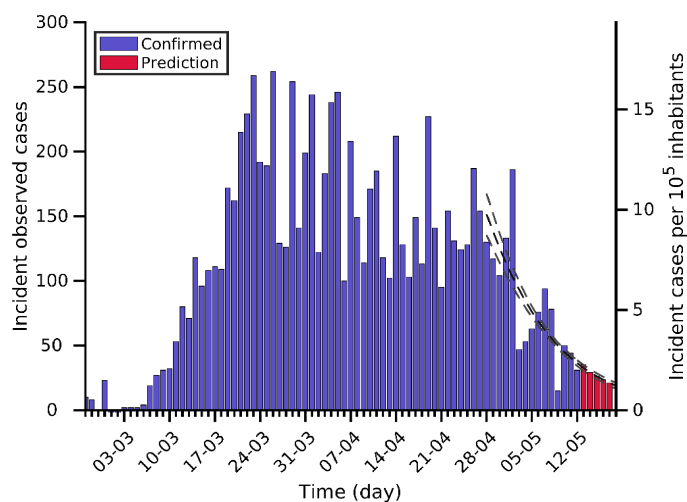
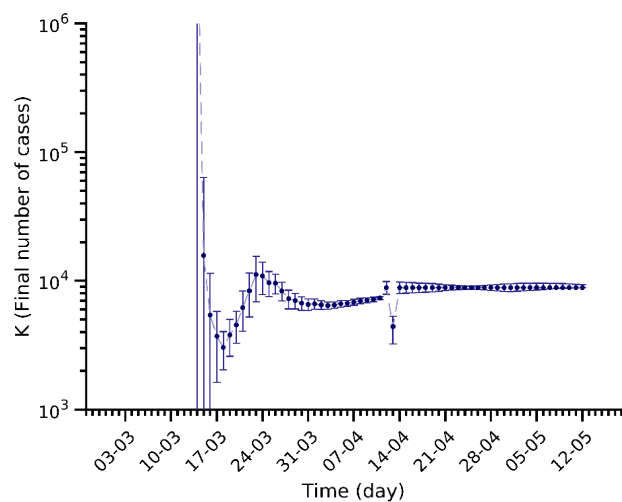
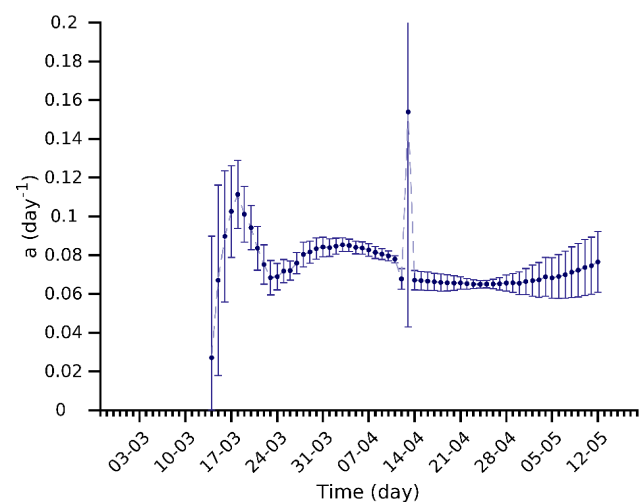
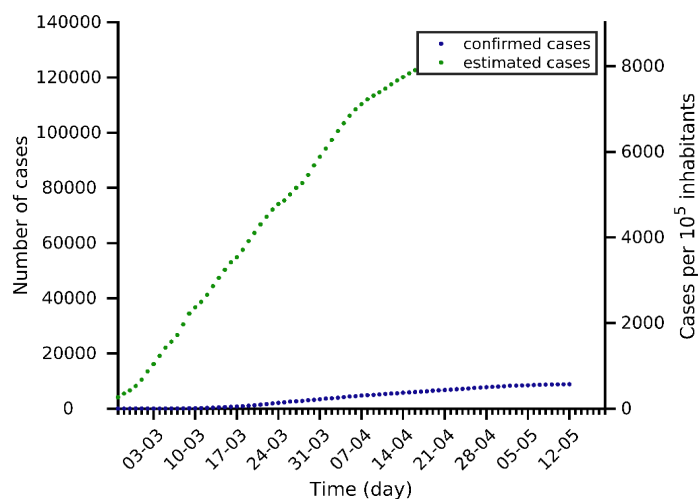
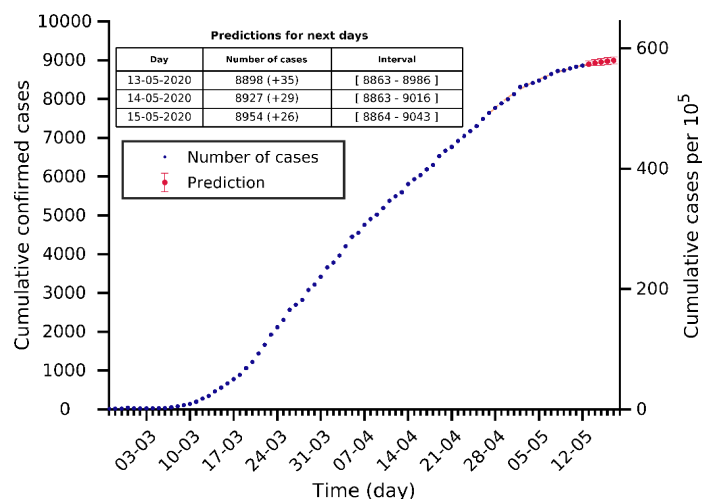
Veneto 12-05-2020. Population: 4.9M. Current cumulated incidence: 383/10⁵



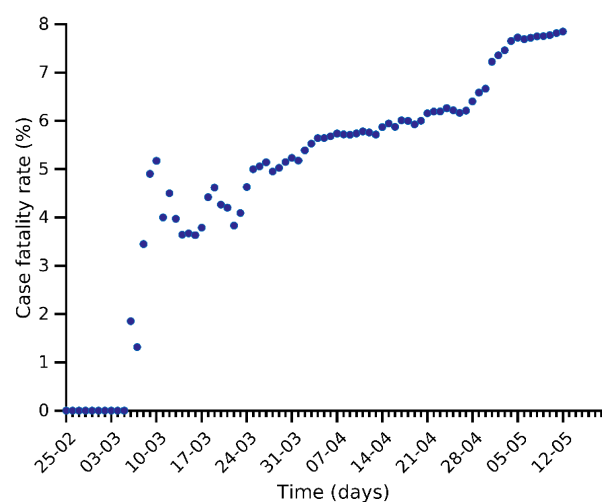
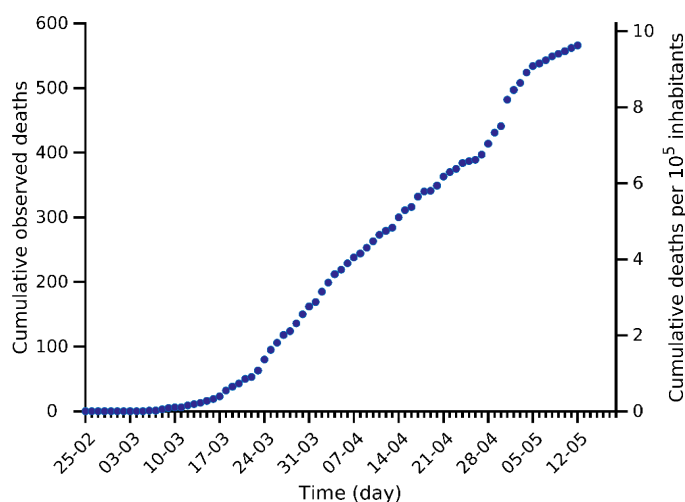
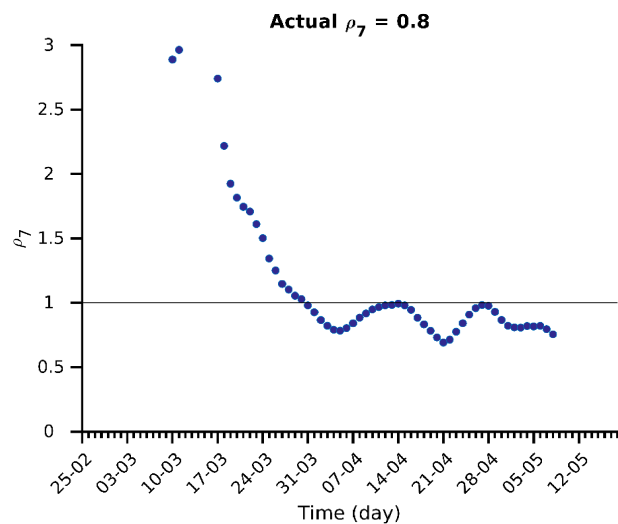
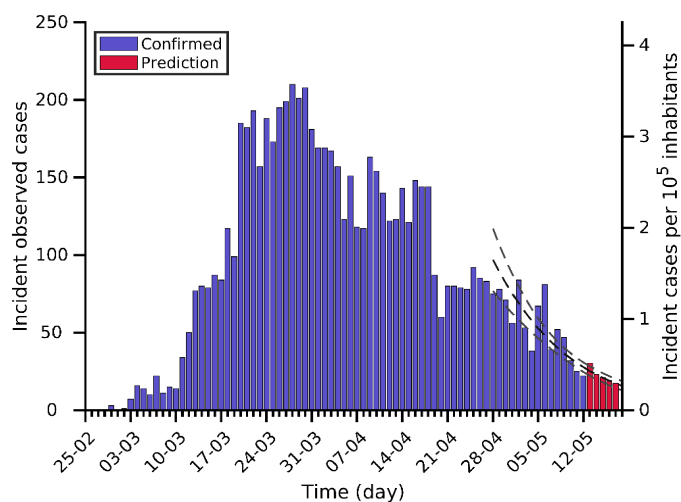
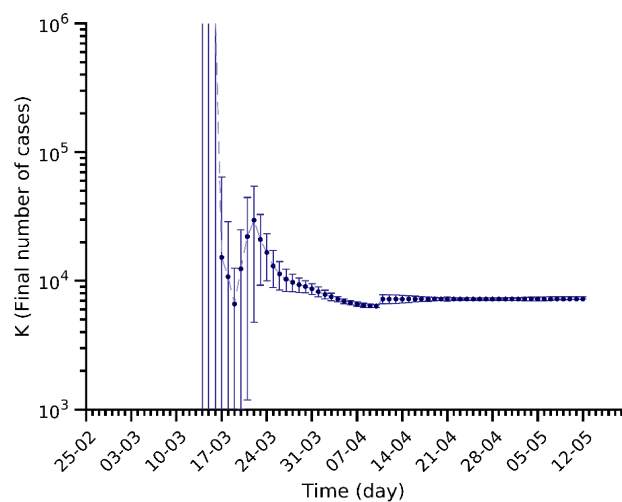
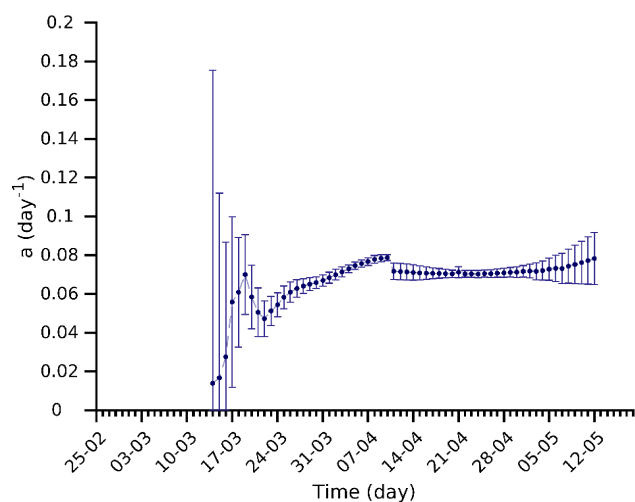
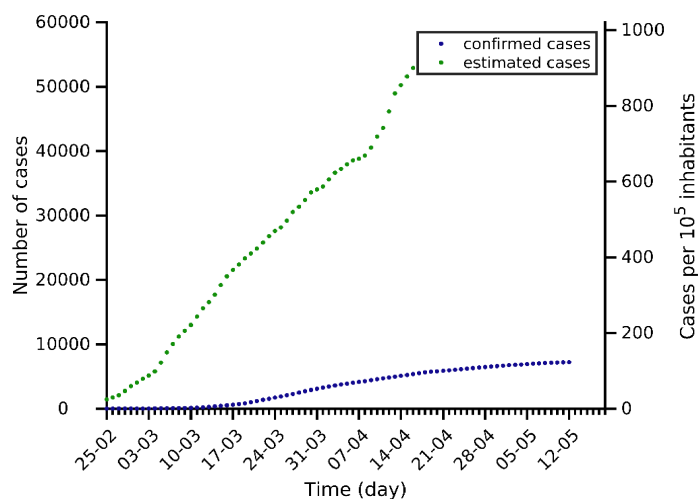
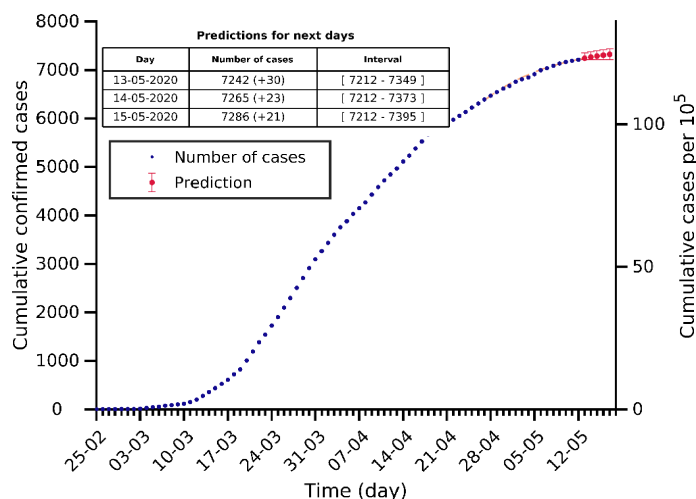
Toscana 12-05-2020. Population: 3.7M. Current cumulated incidence: 263/10⁵



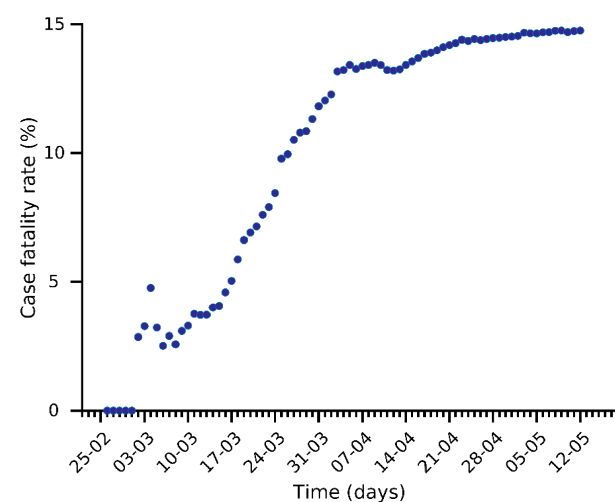
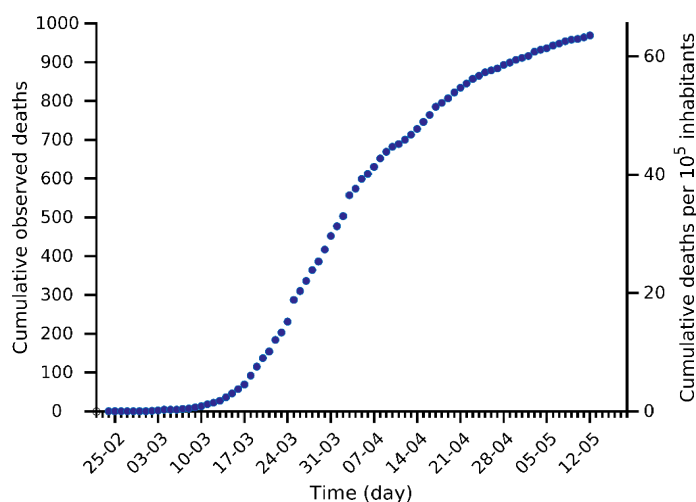
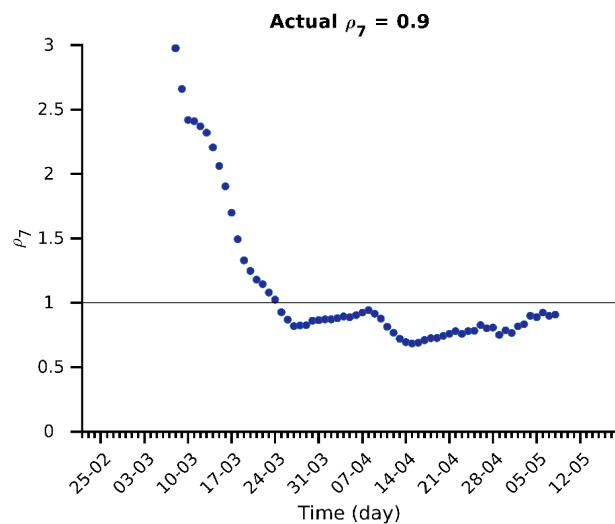
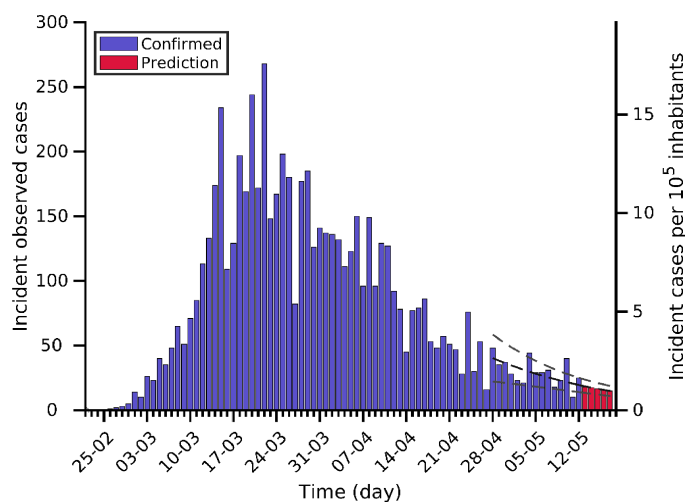
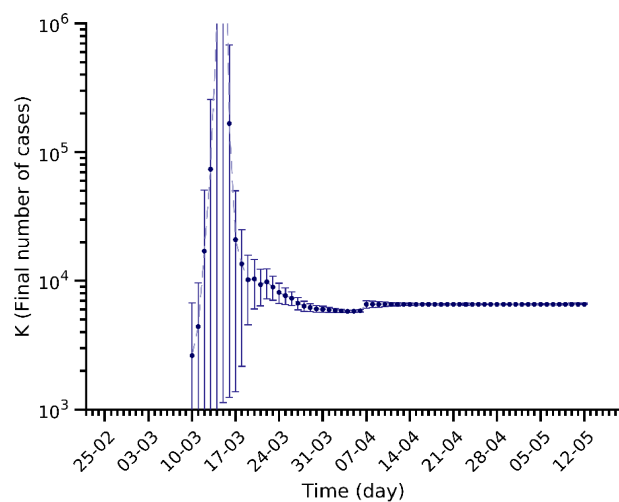
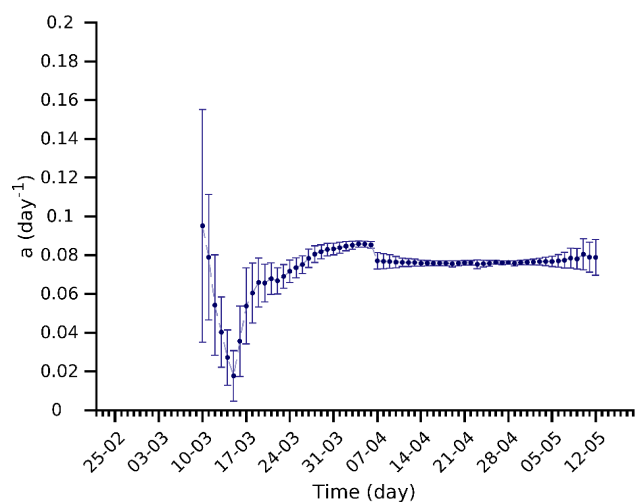
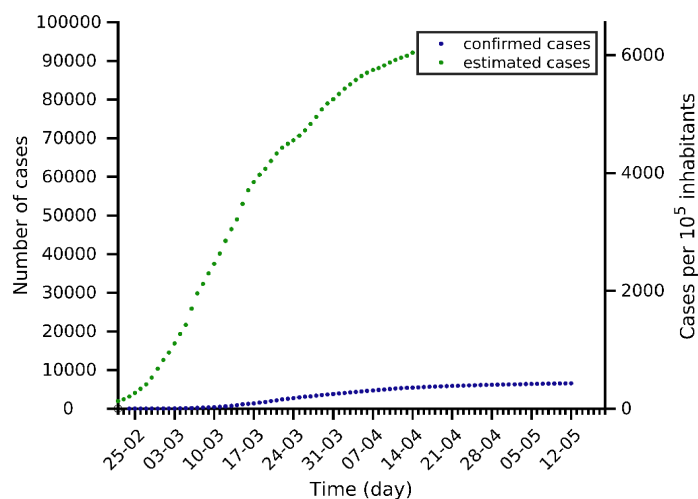
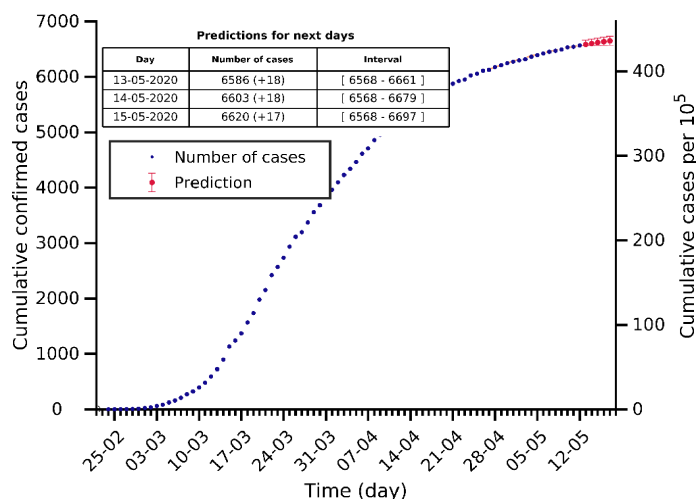
Liguria 12-05-2020. Population: 1.6M. Current cumulated incidence: 571/10⁵



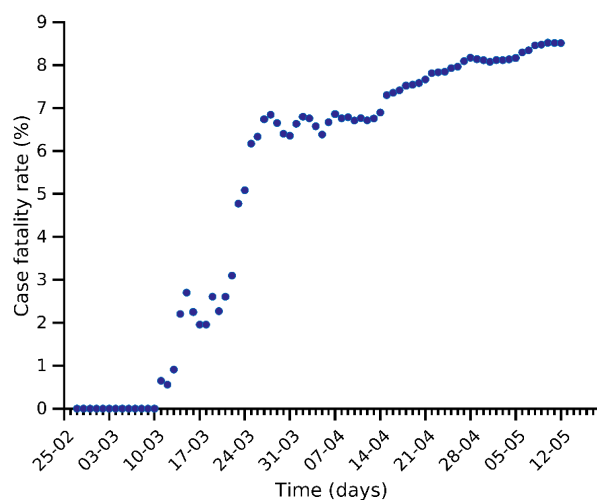
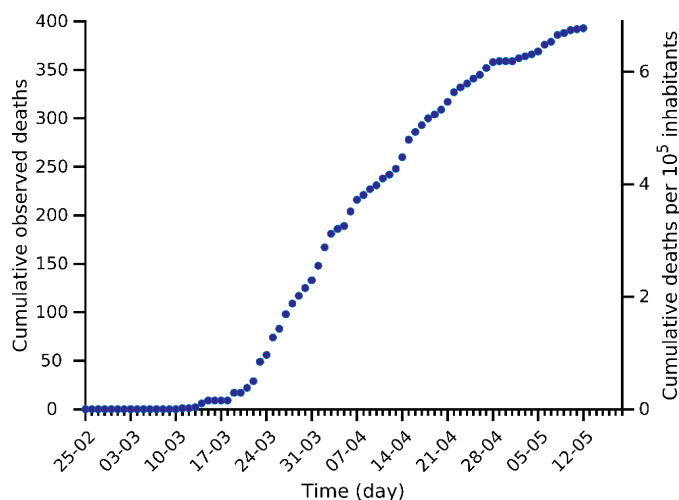
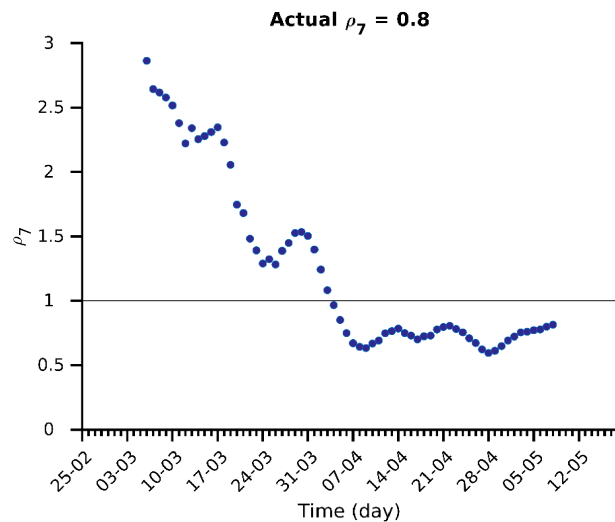
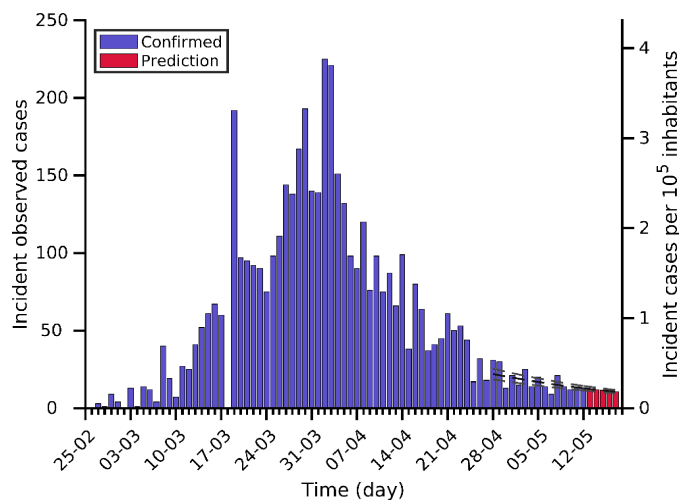
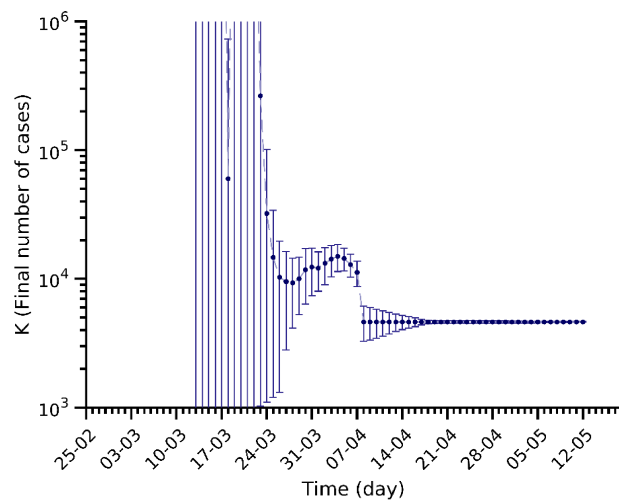
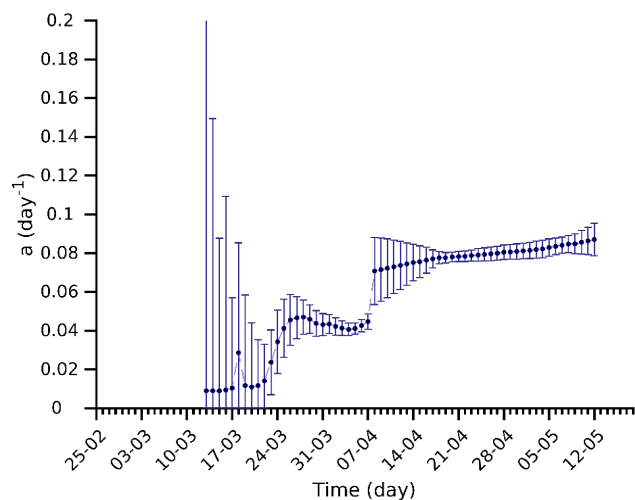
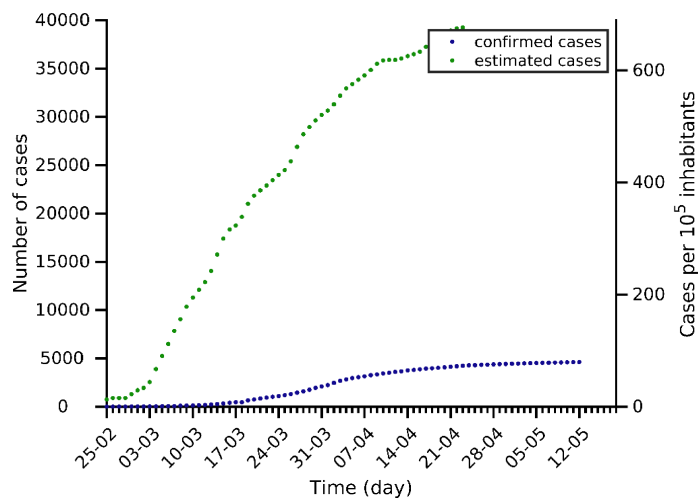
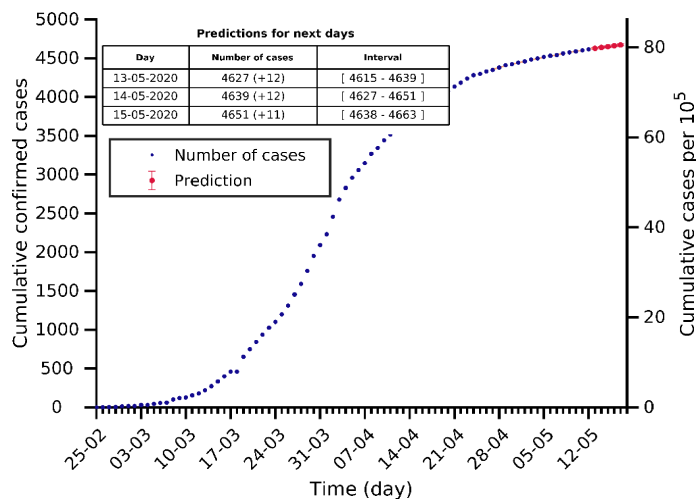
Lazio 12-05-2020. Population: 5.9M. Current cumulated incidence: 123/10⁵



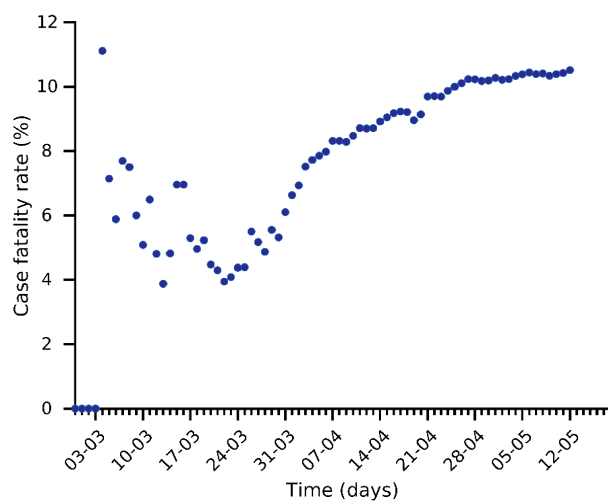
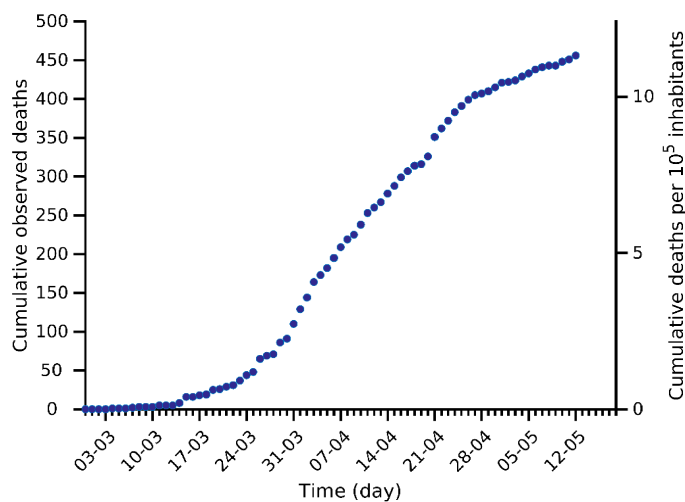
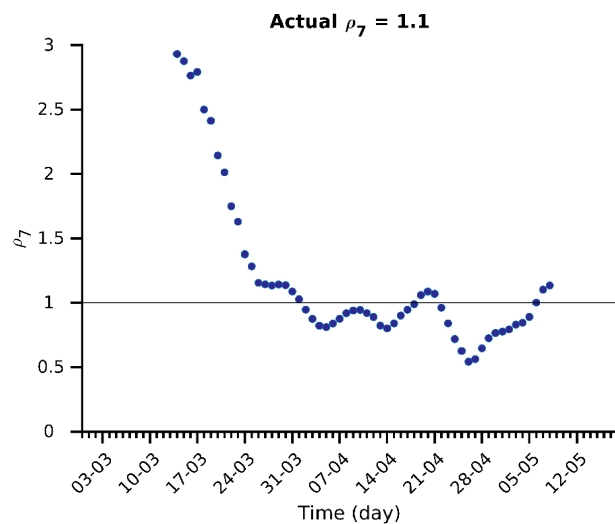
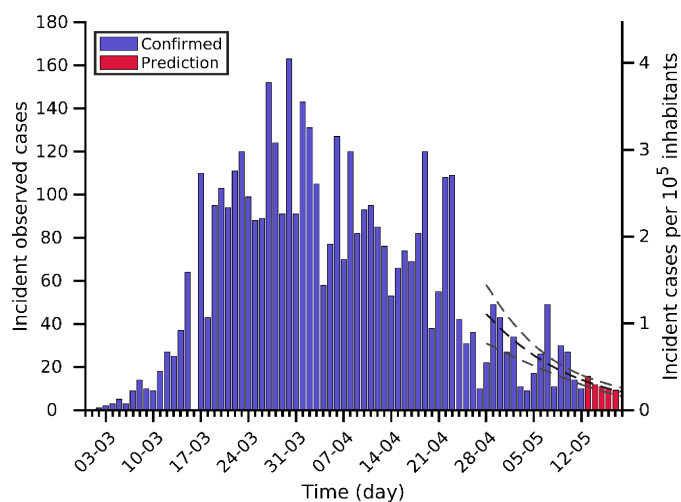
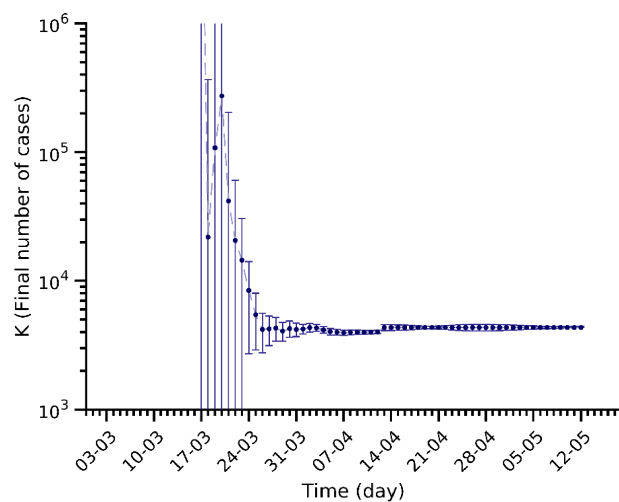
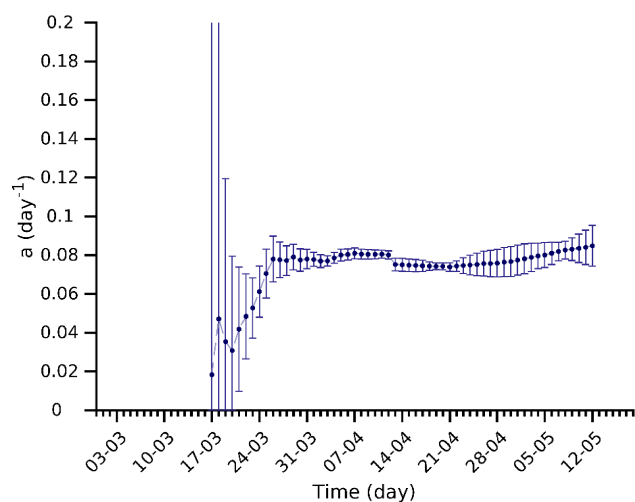
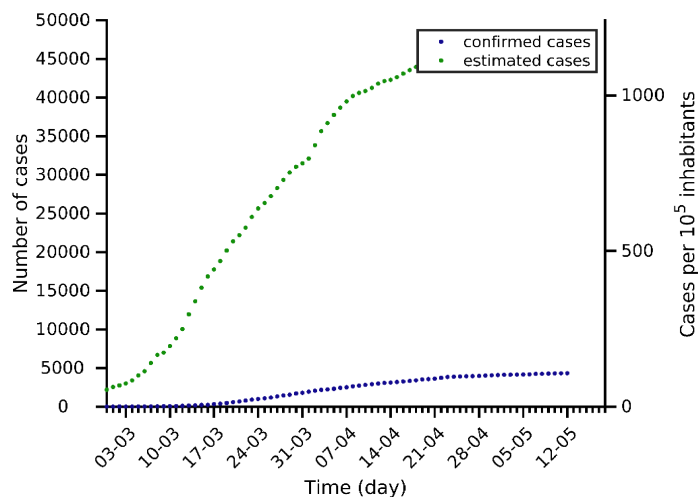
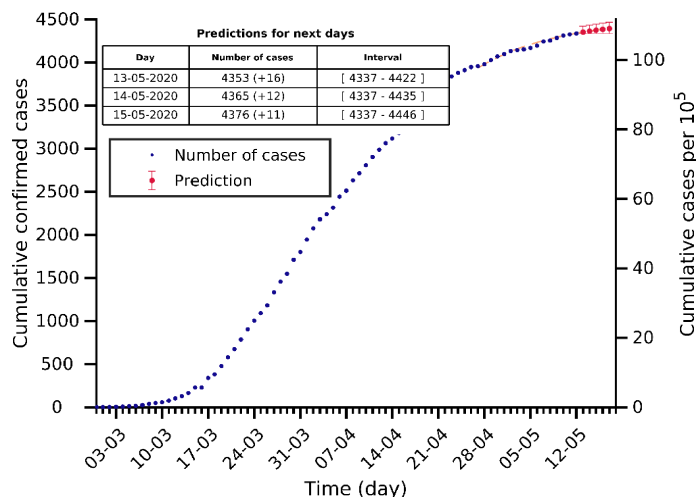
Marche 12-05-2020. Population: 1.5M. Current cumulated incidence: 431/10⁵



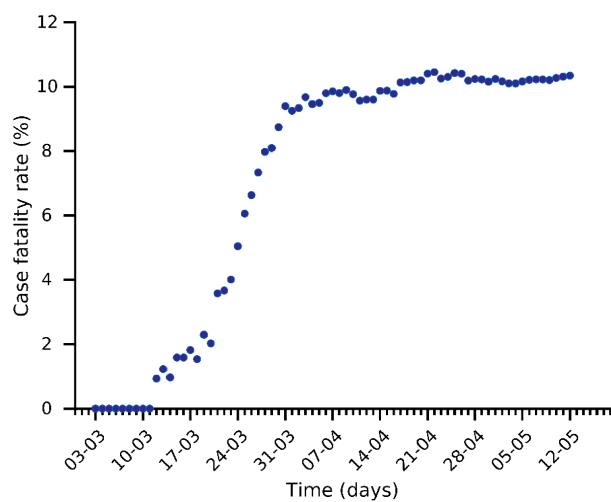
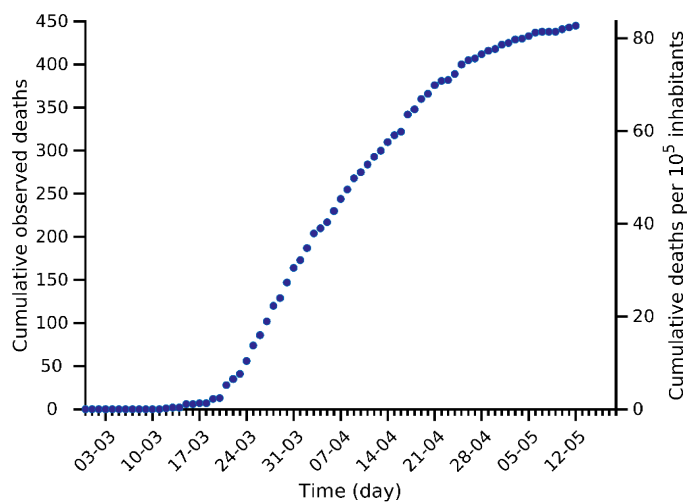
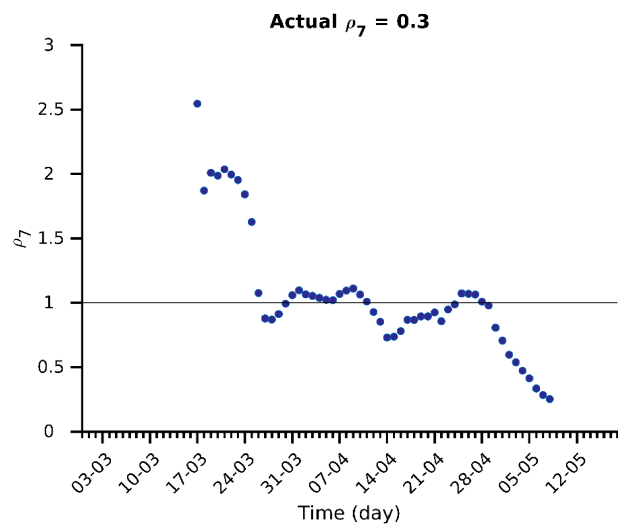
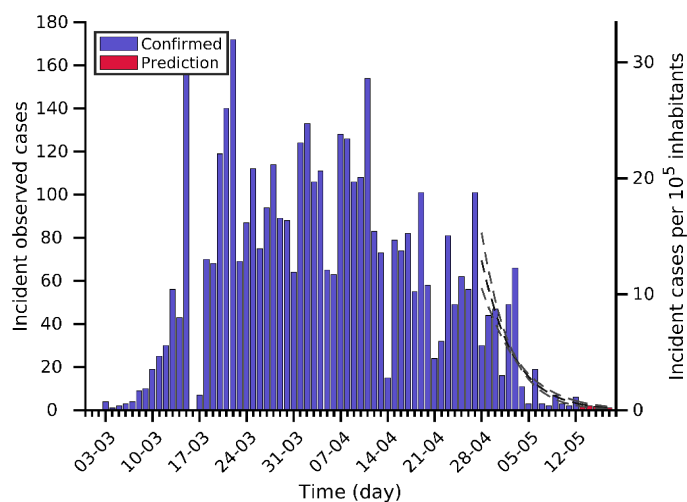
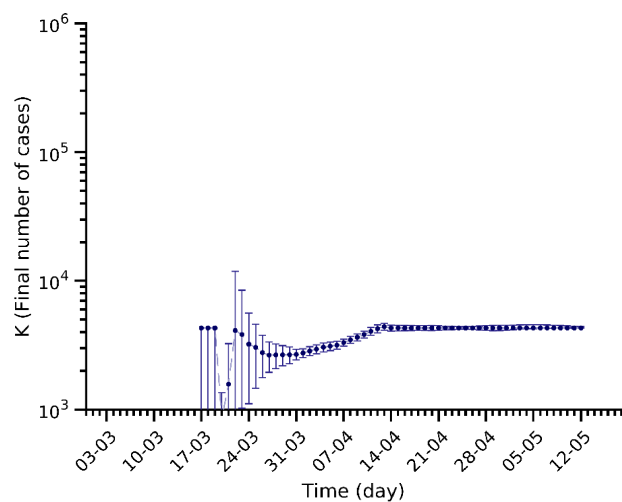
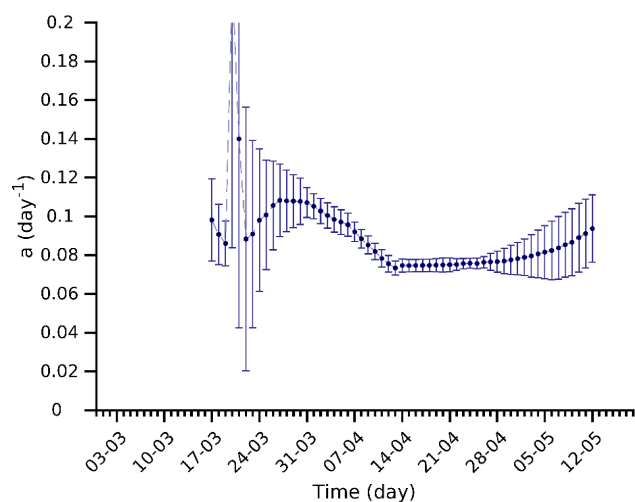
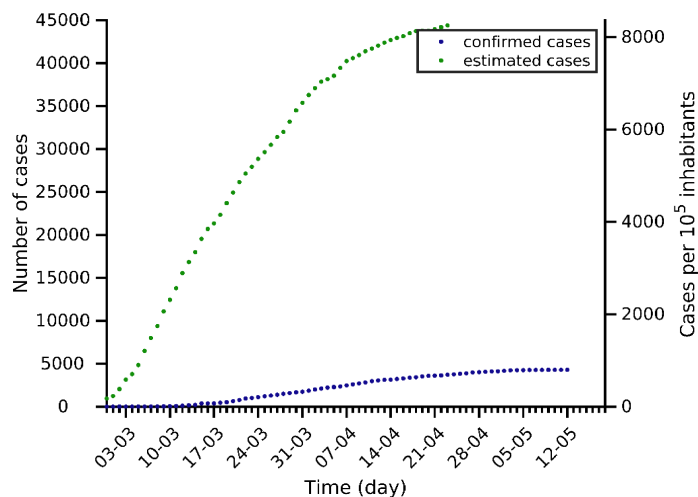
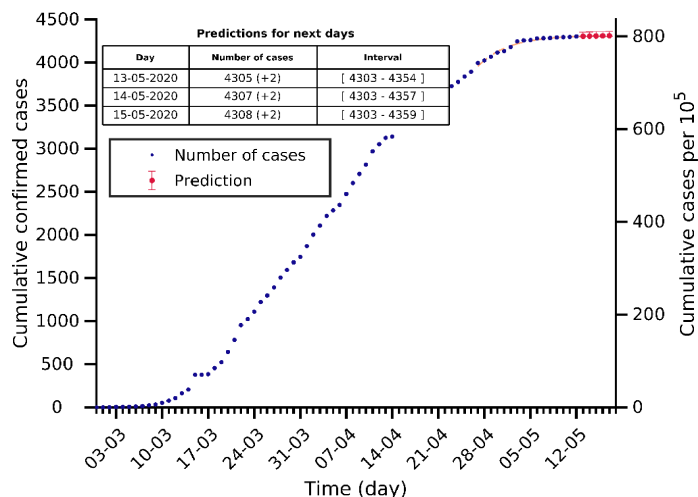
Campania 12-05-2020. Population: 5.8M. Current cumulated incidence: 80/10⁵



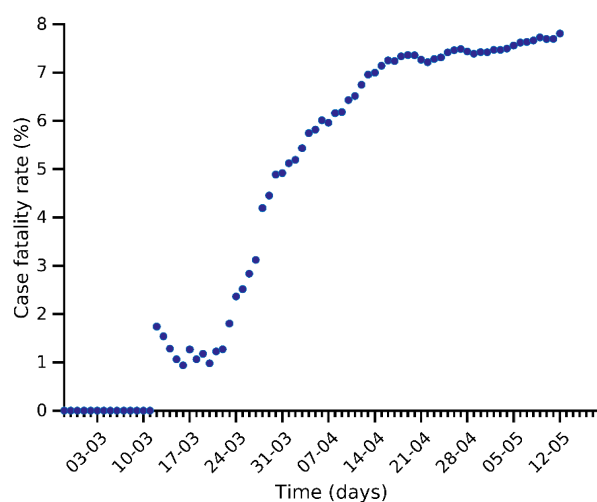
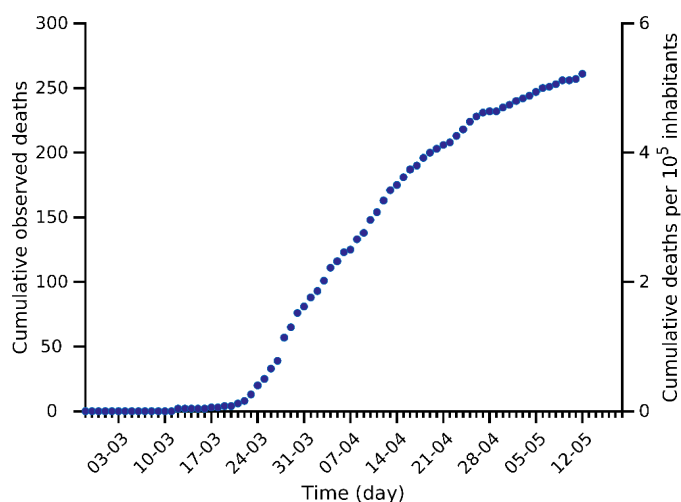
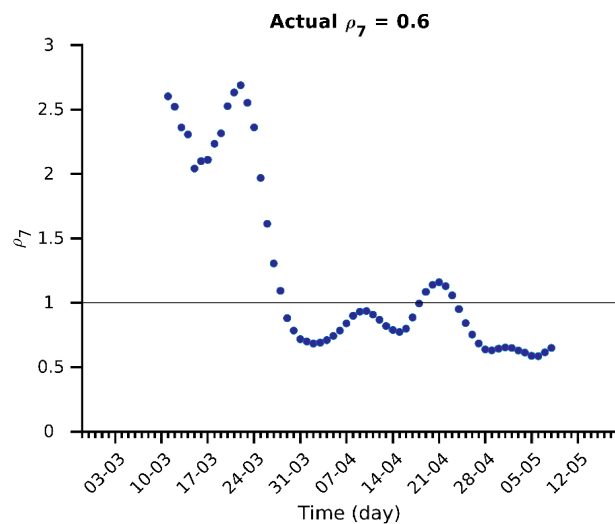
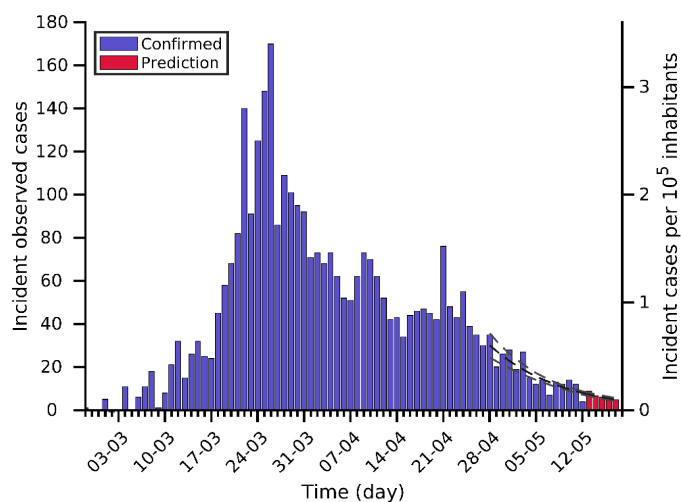
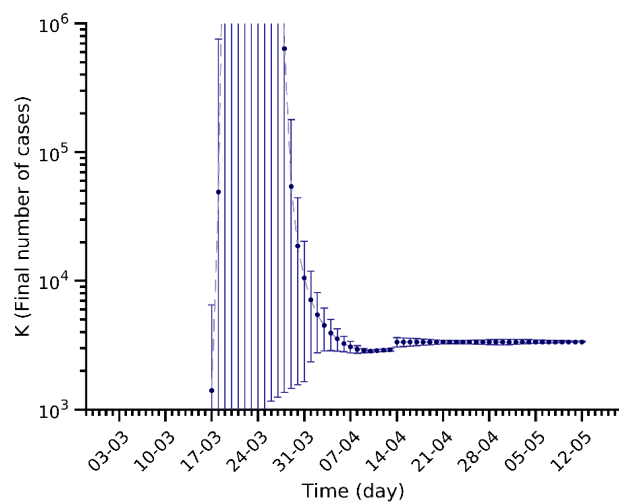
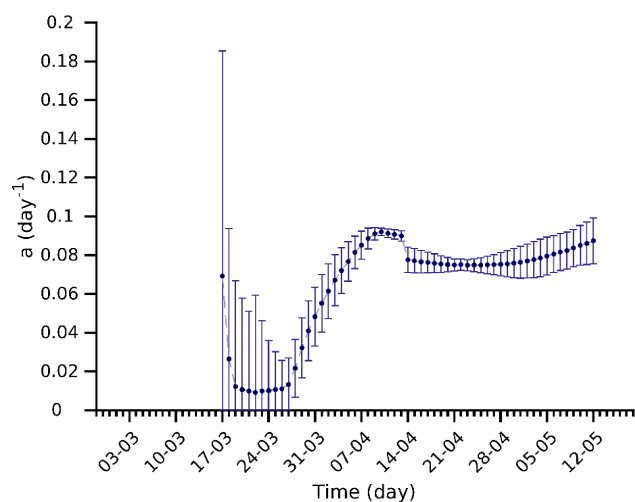
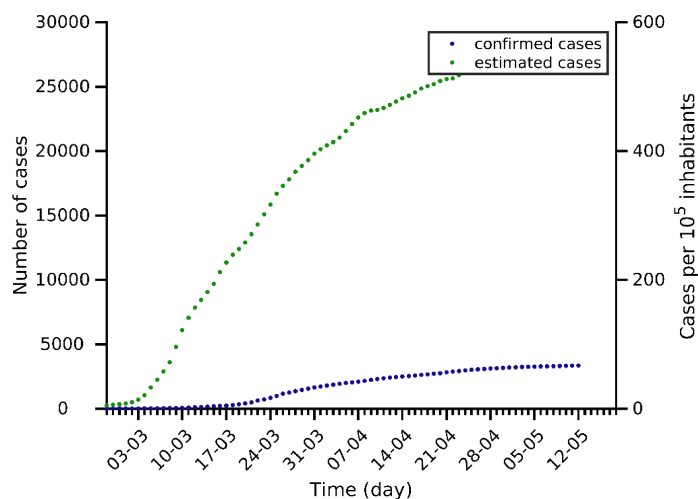
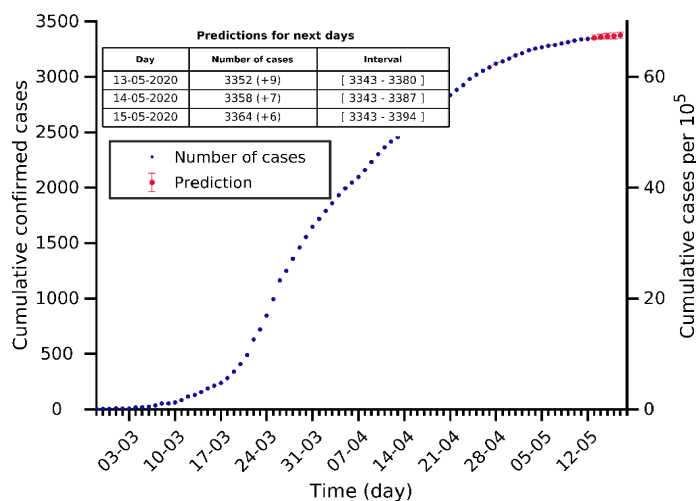
Puglia 12-05-2020. Population: 4.0M. Current cumulated incidence: 108/10⁵



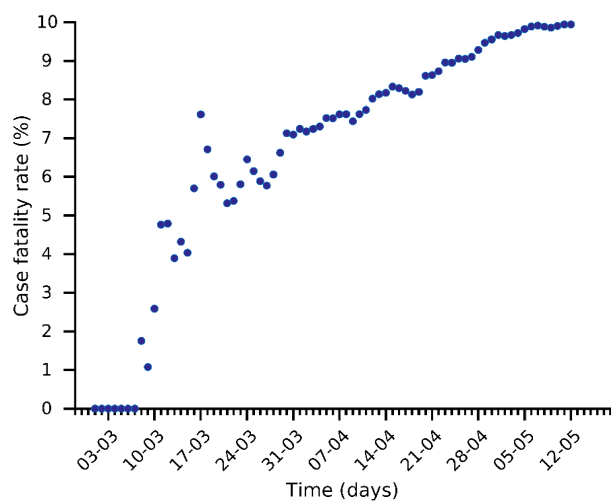
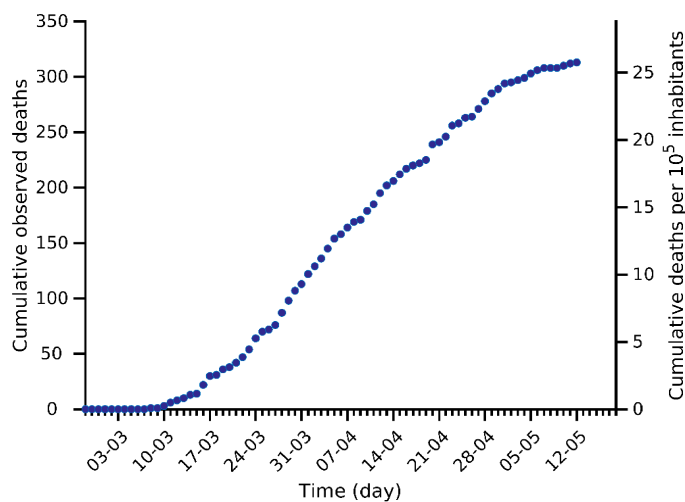
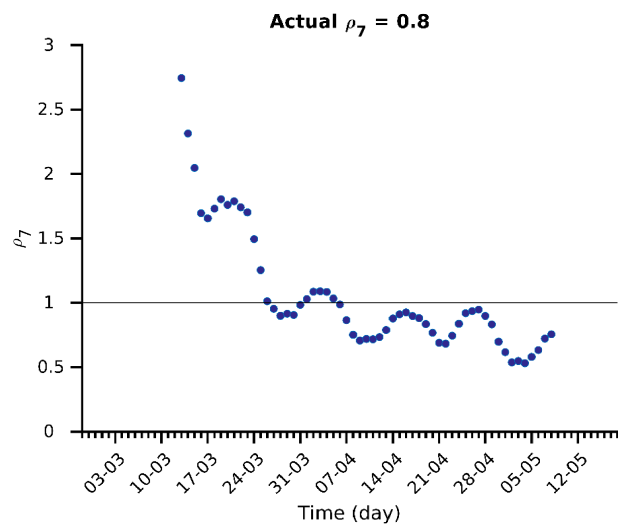
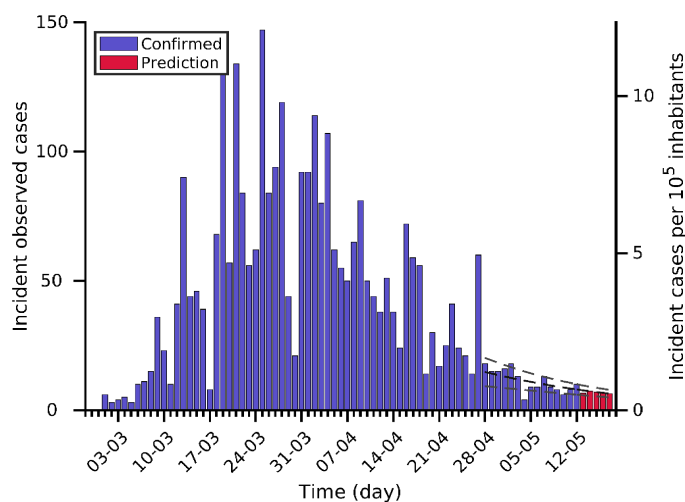
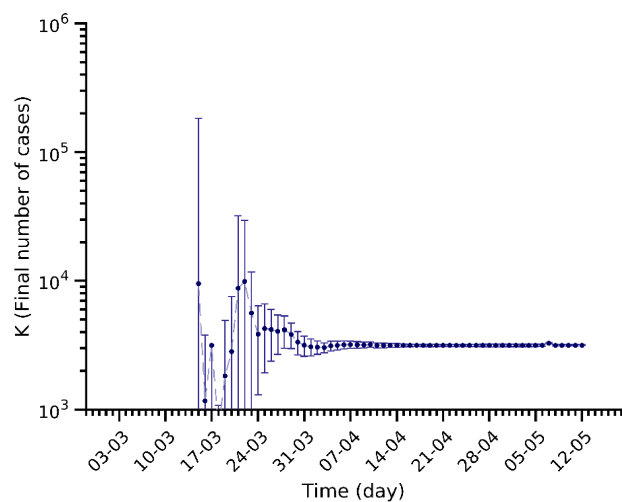
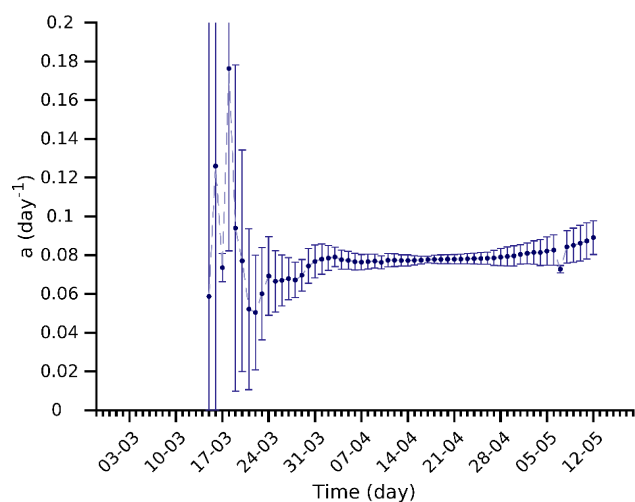
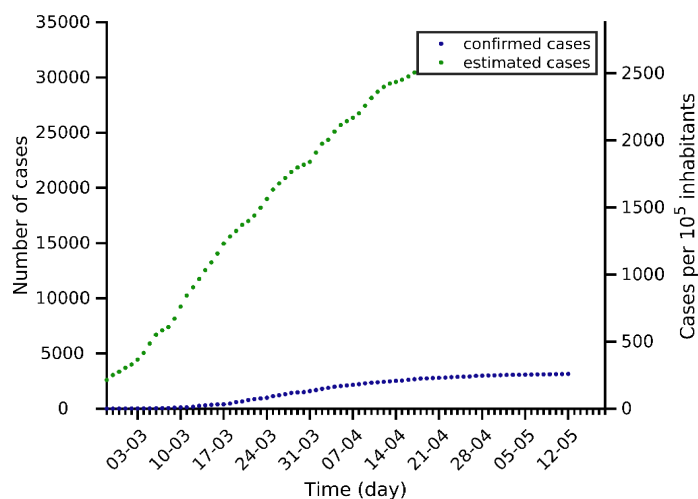
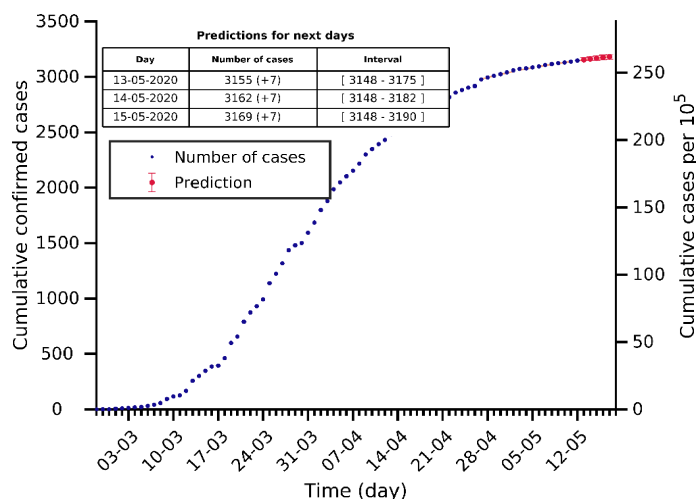
Trento 12-05-2020. Population: 0.5M. Current cumulated incidence: 800/10⁵



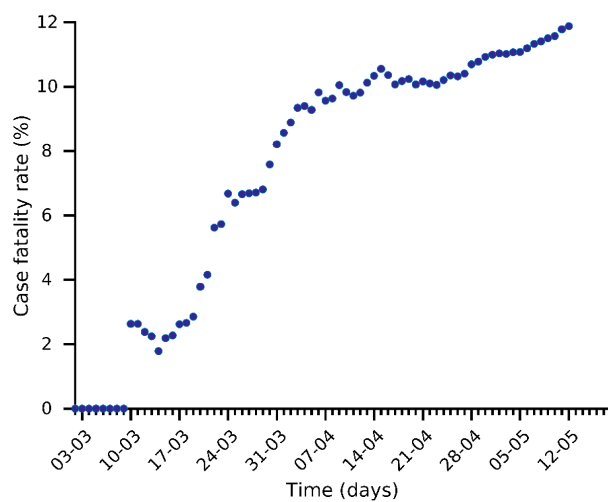
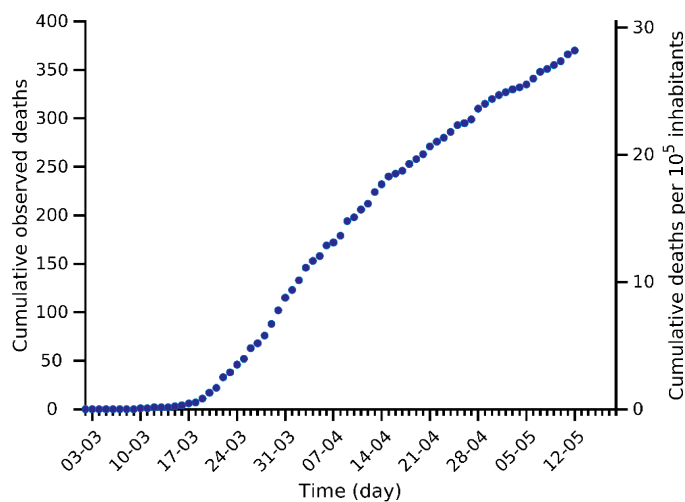
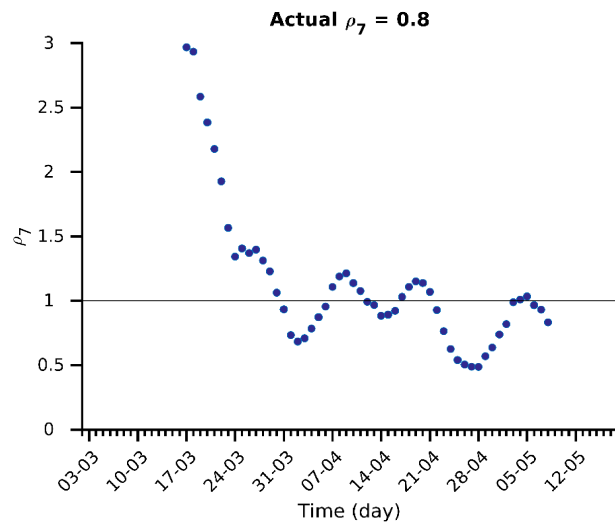
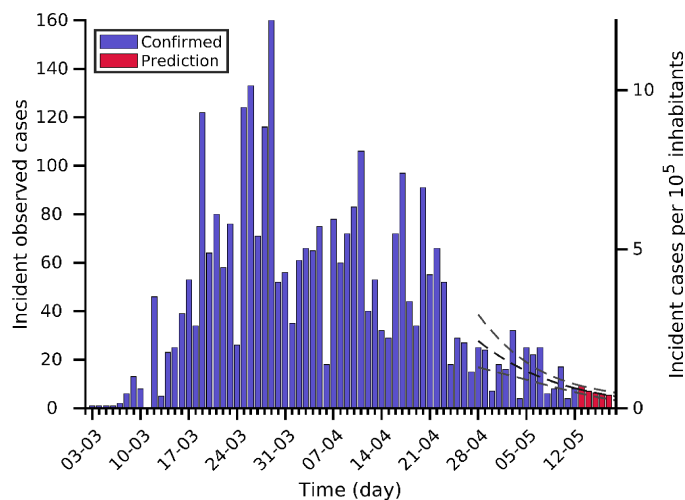
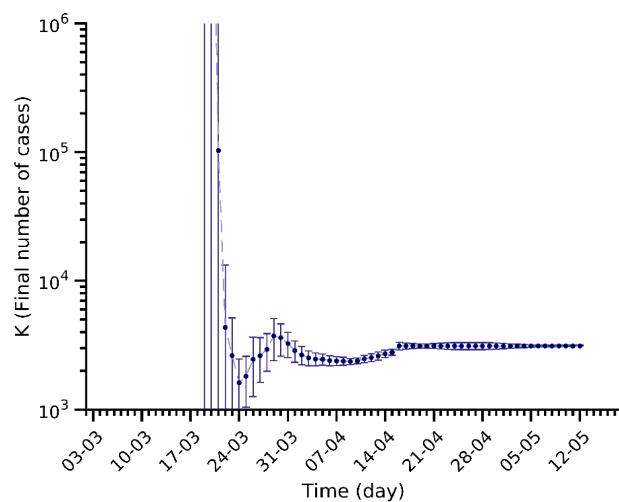
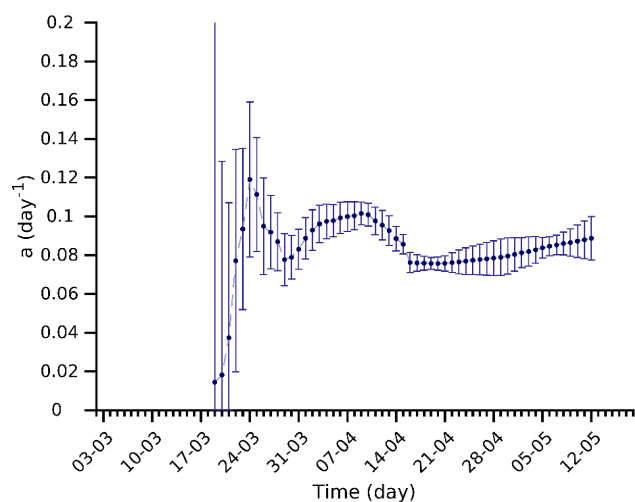
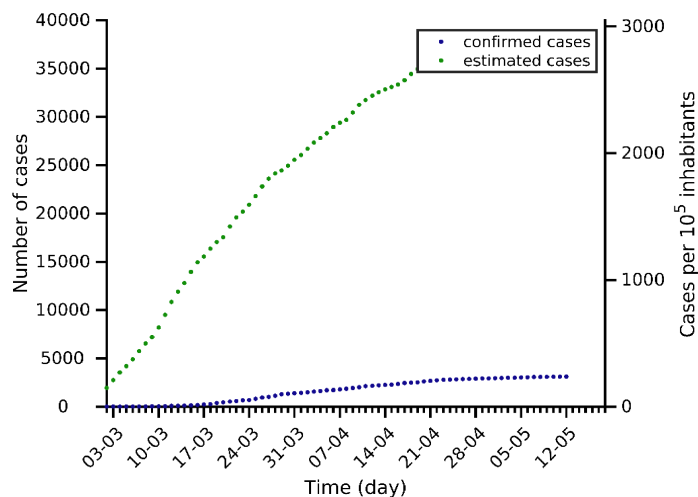
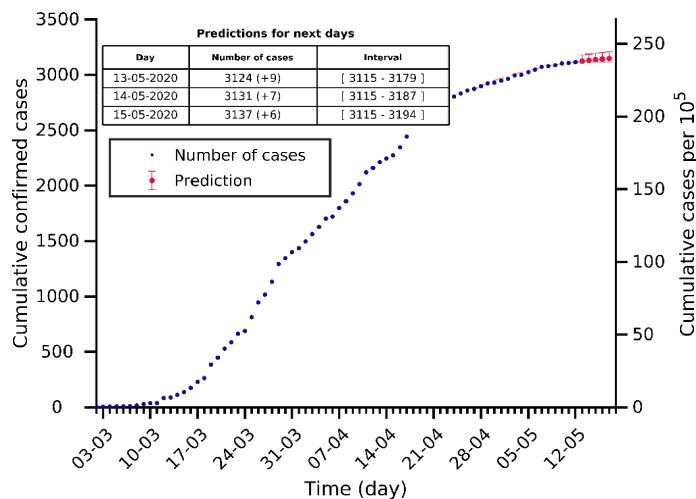
Sicilia 12-05-2020. Population: 5.0M. Current cumulated incidence: 67/10⁵



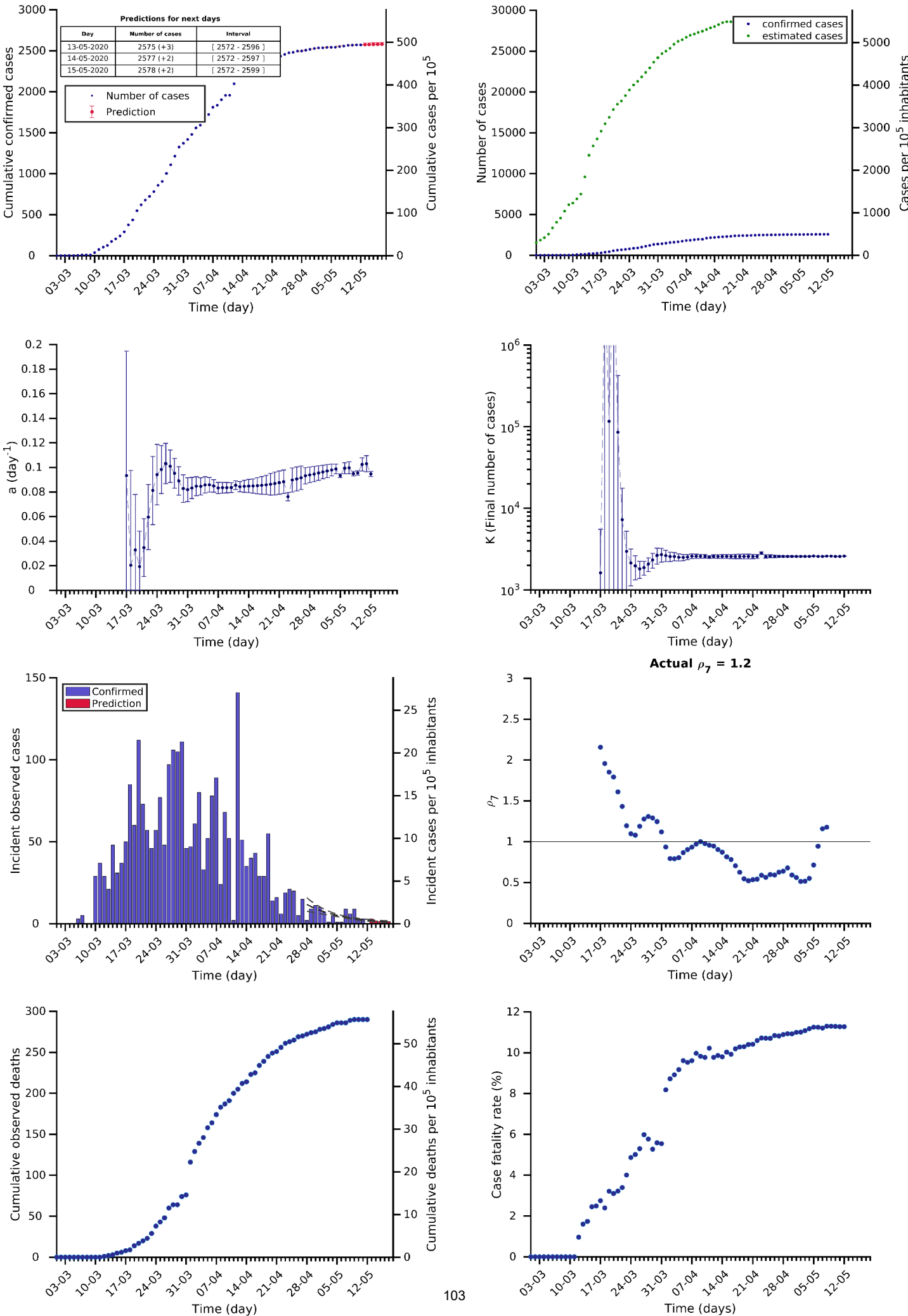
Friuli Venezia Giulia 12-05-2020. Population: 1.2M. Current cumulated incidence: 2



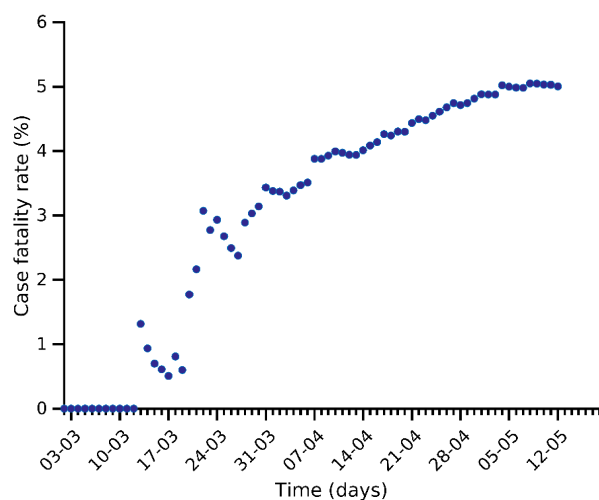
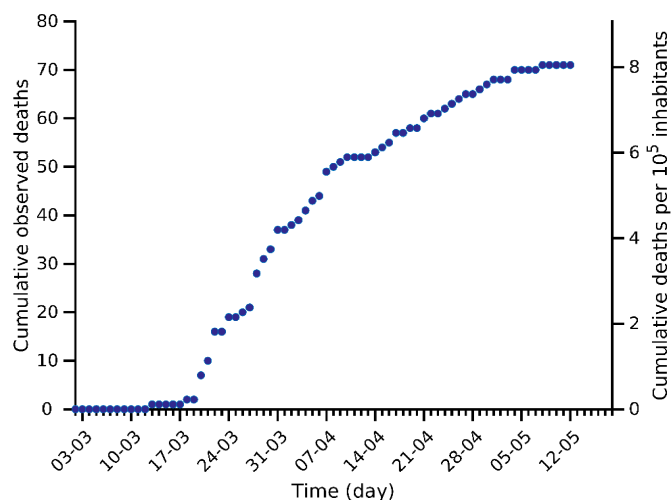
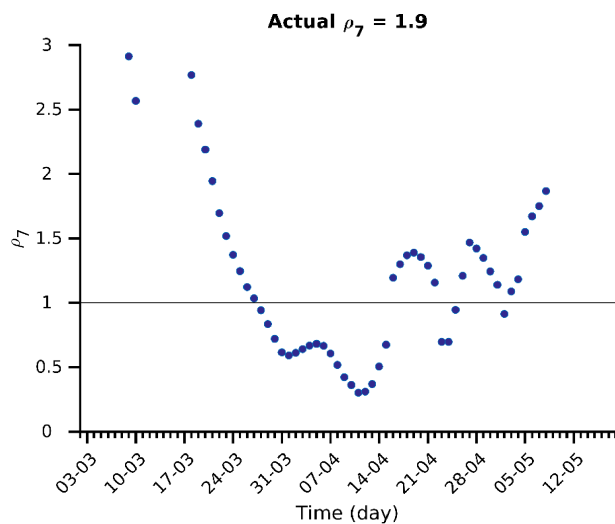
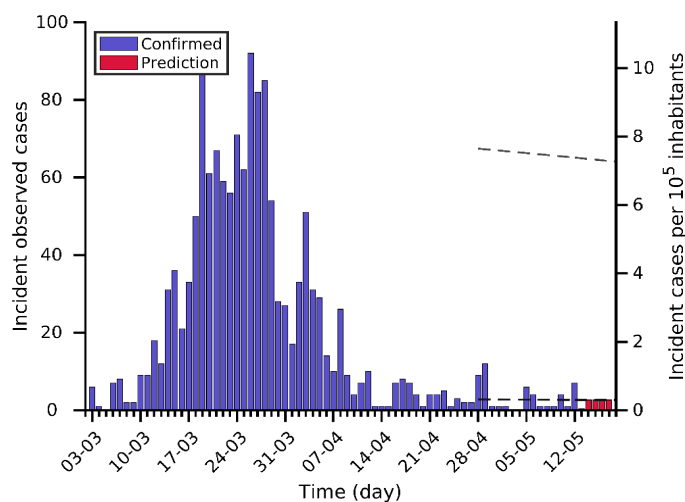
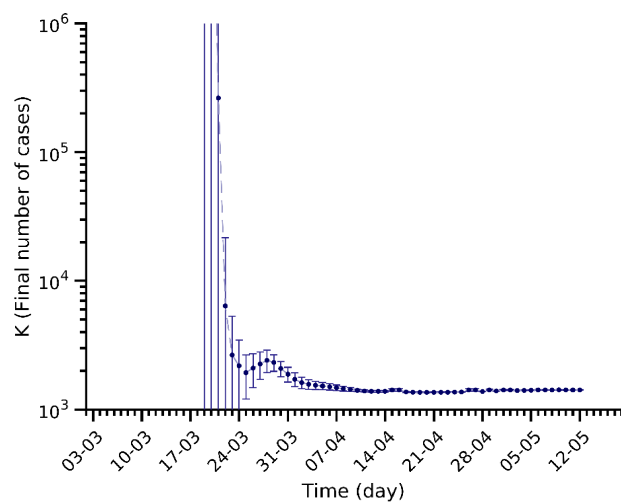
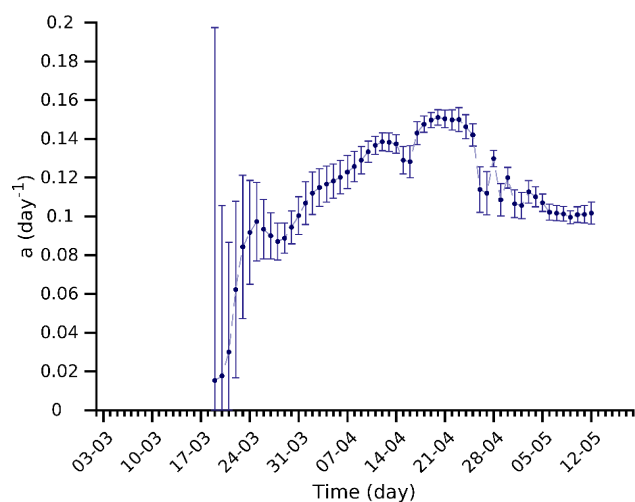
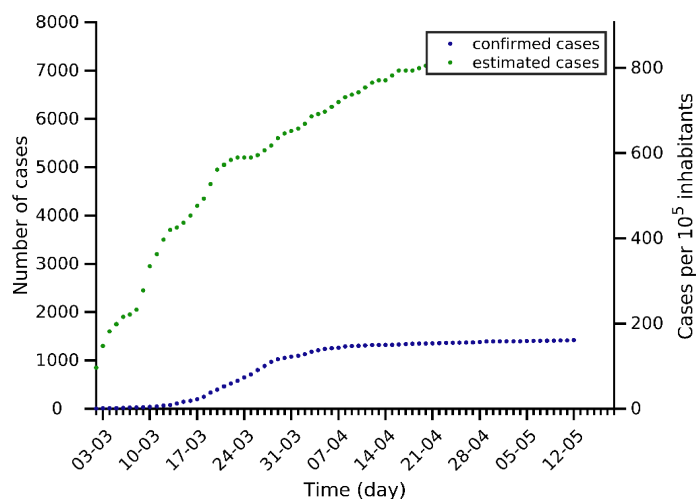
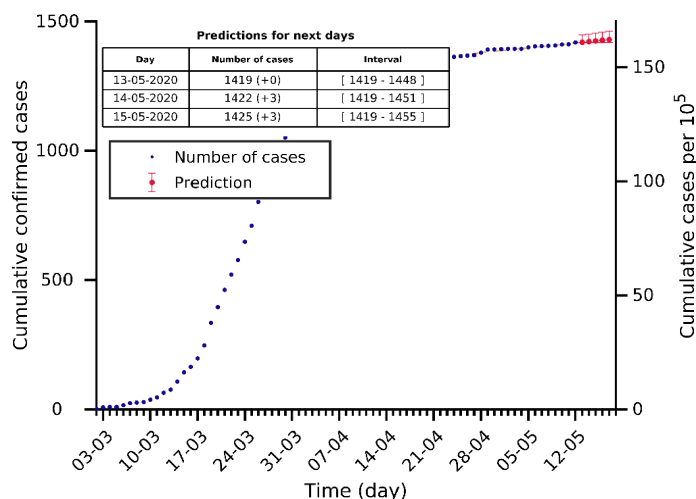
Abruzzo 12-05-2020. Population: 1.3M. Current cumulated incidence: 237/10⁵



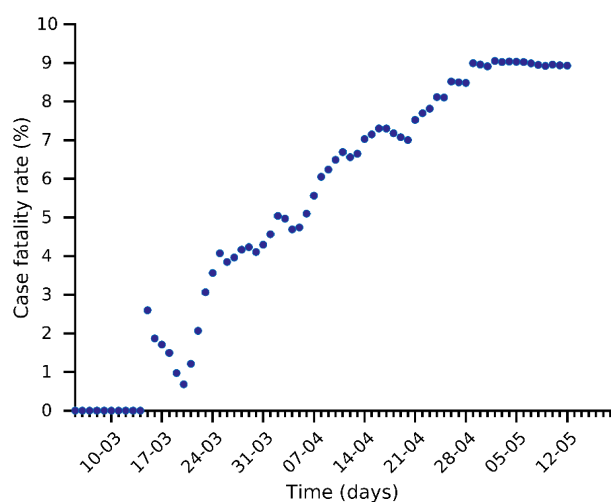
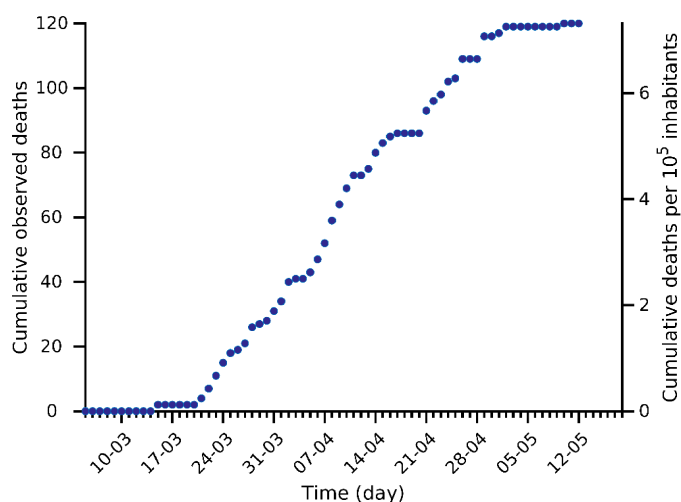
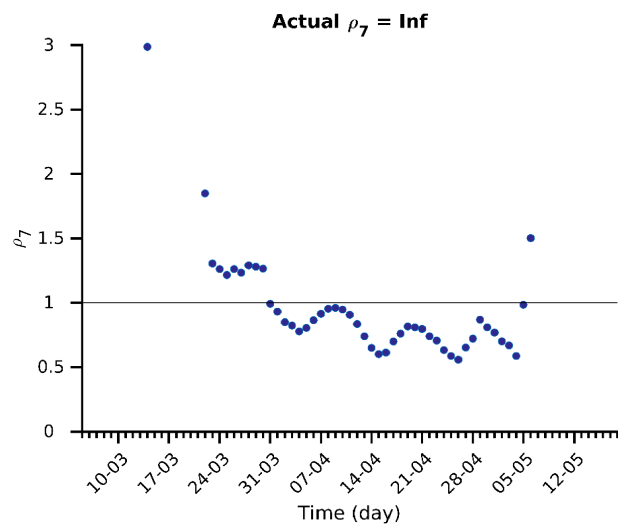
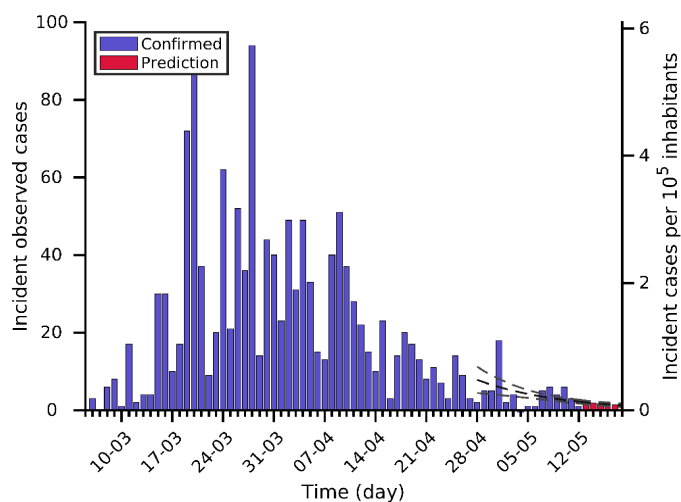
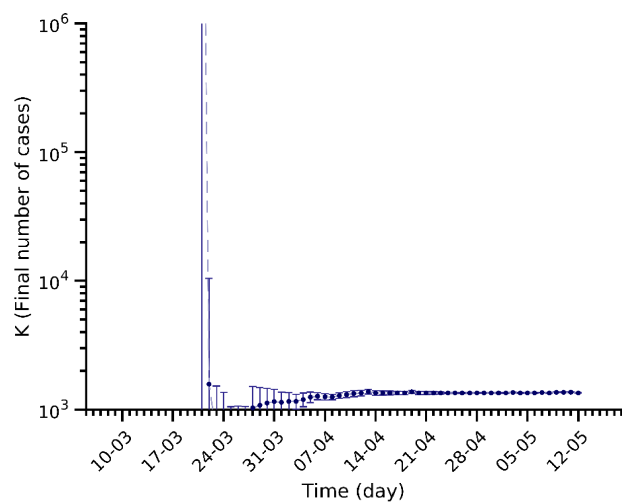
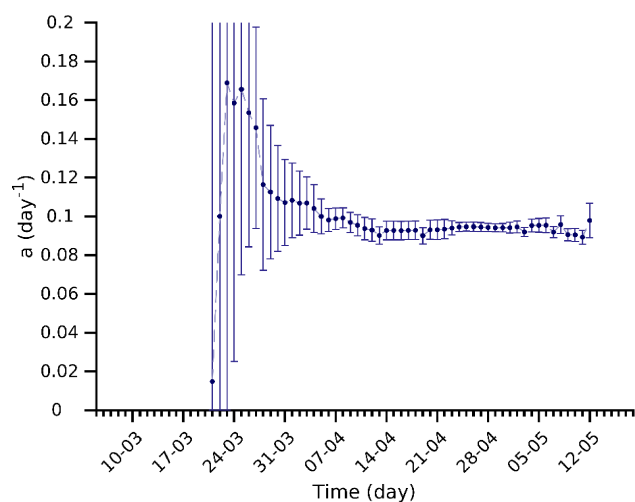
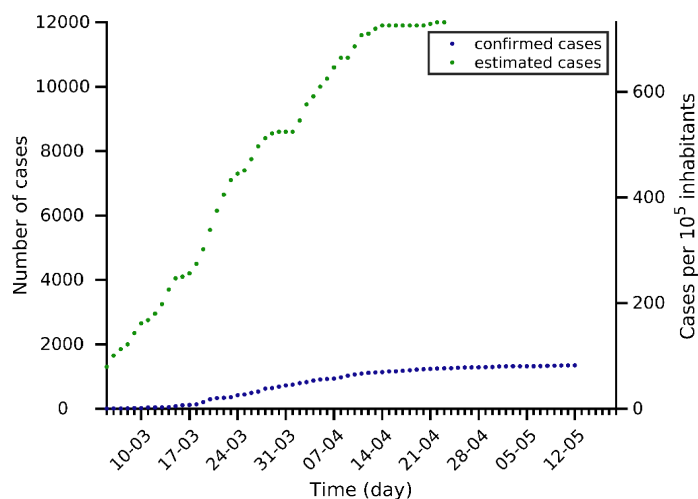
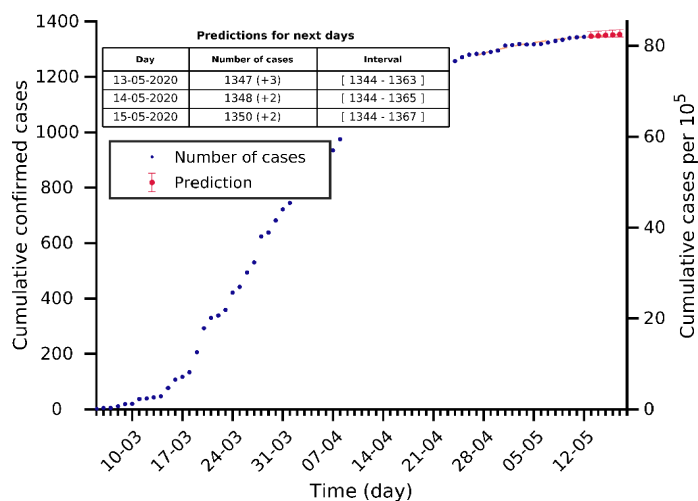
Bolzano 12-05-2020. Population: 0.5M. Current cumulated incidence: 494/10⁵



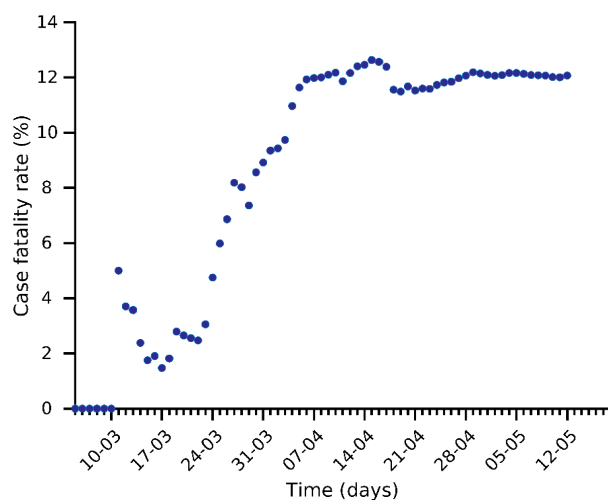
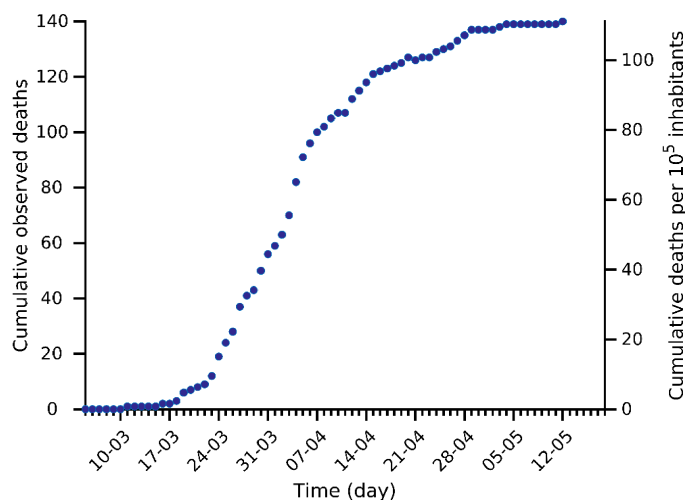
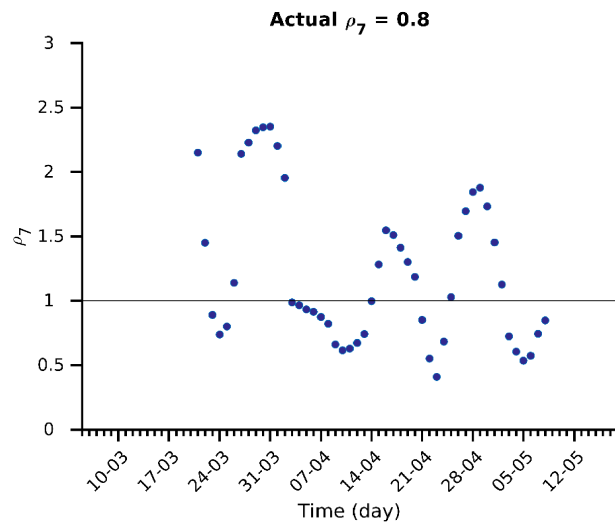
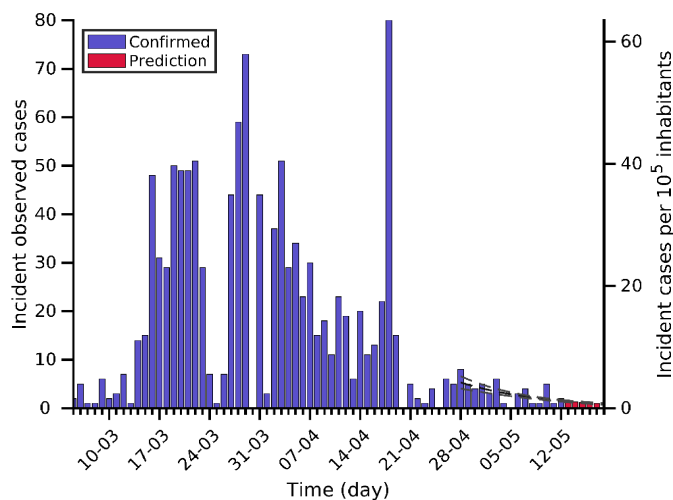
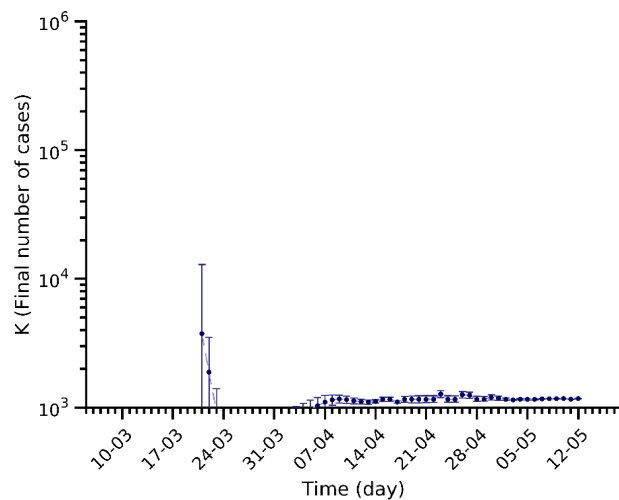
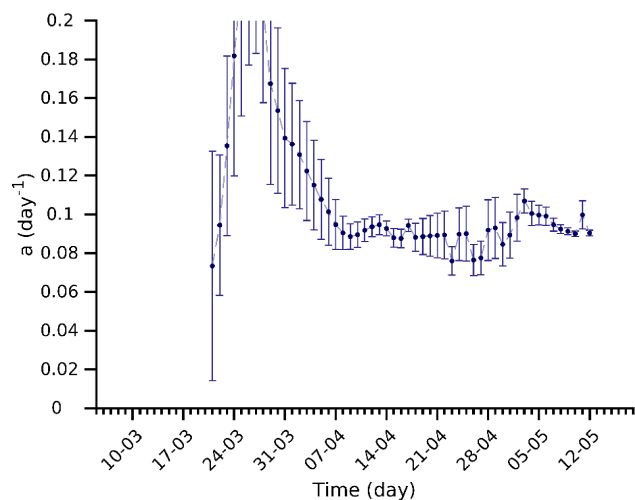
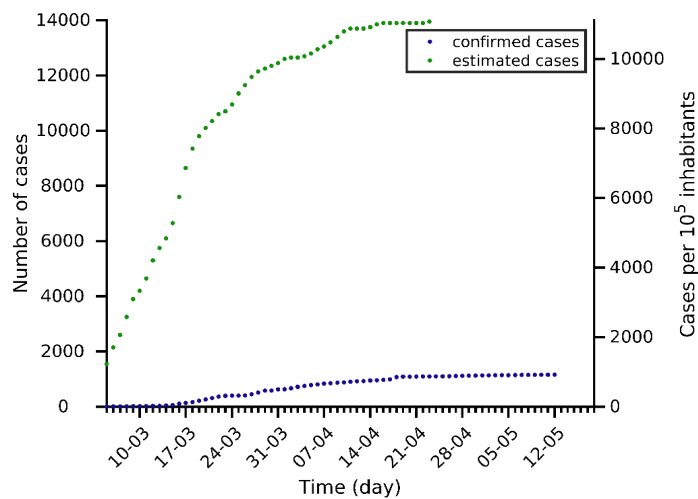
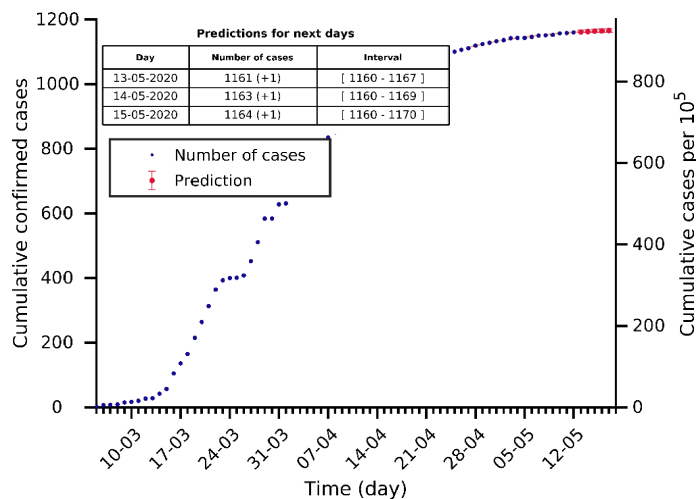
Umbria 12-05-2020. Population: 0.9M. Current cumulated incidence: 161/10⁵



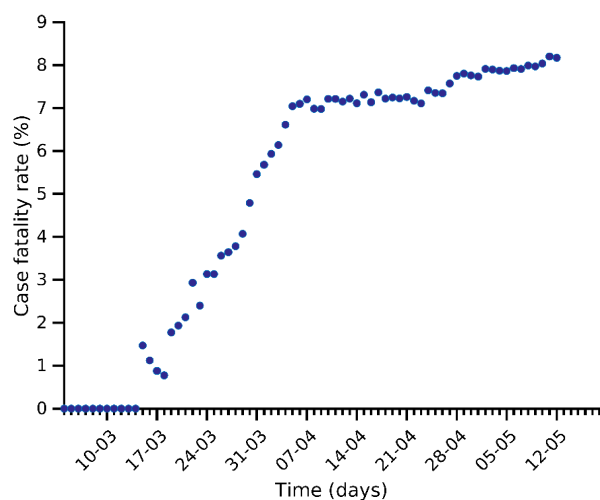
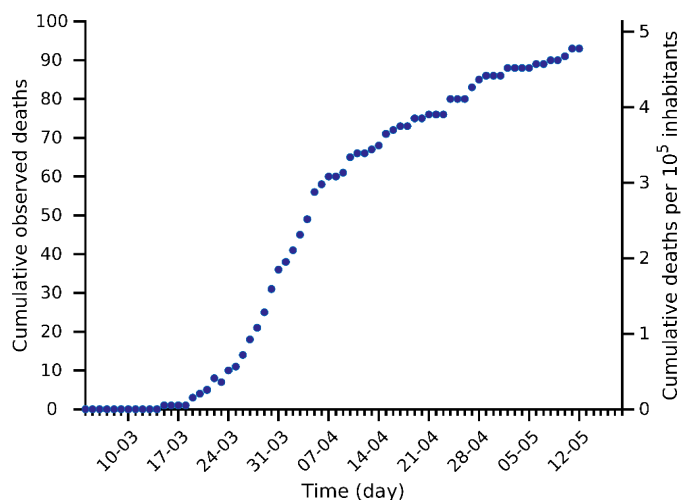
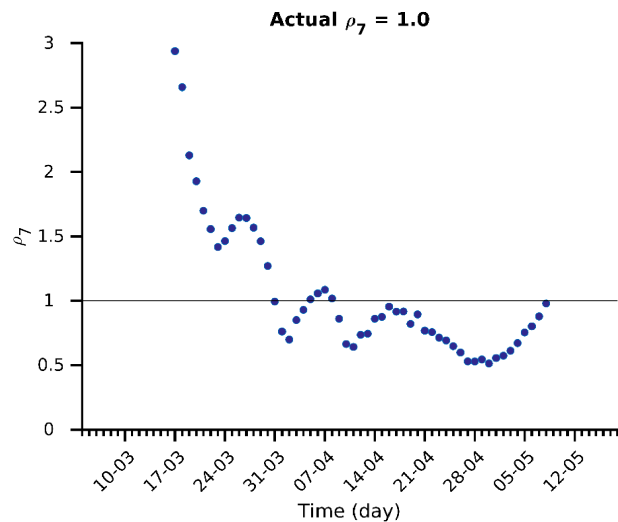
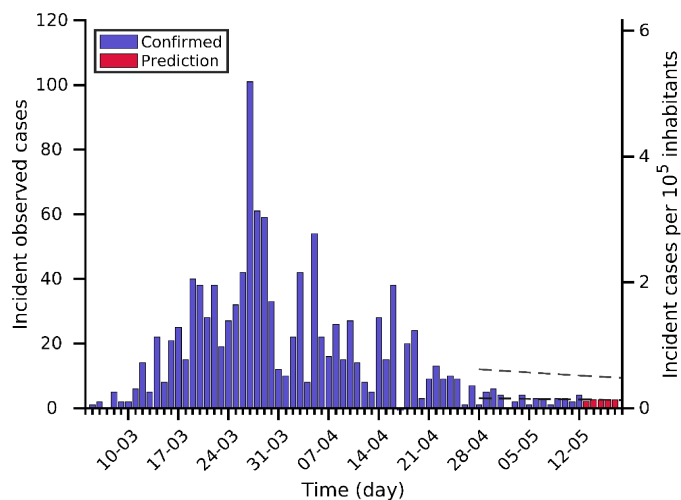
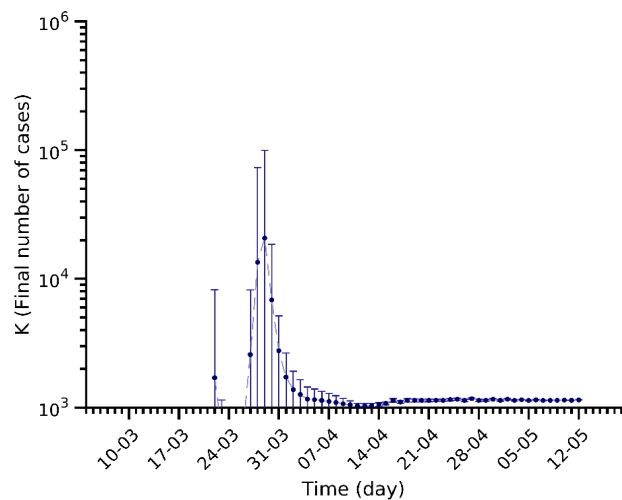
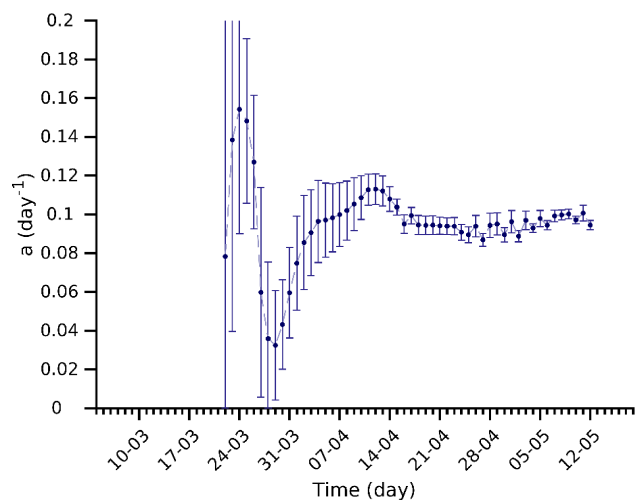
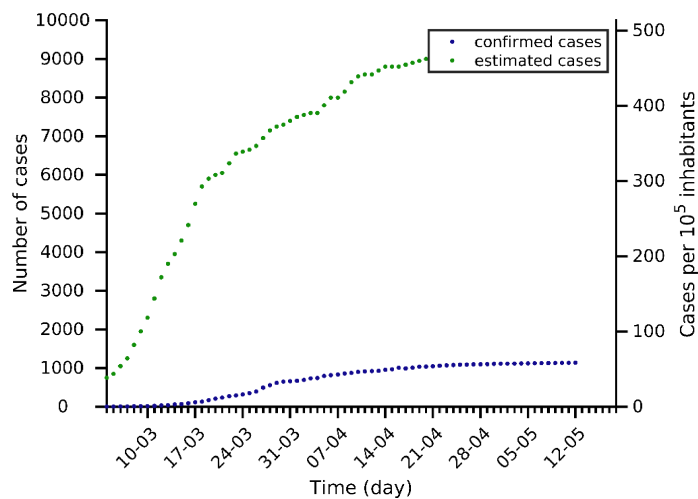
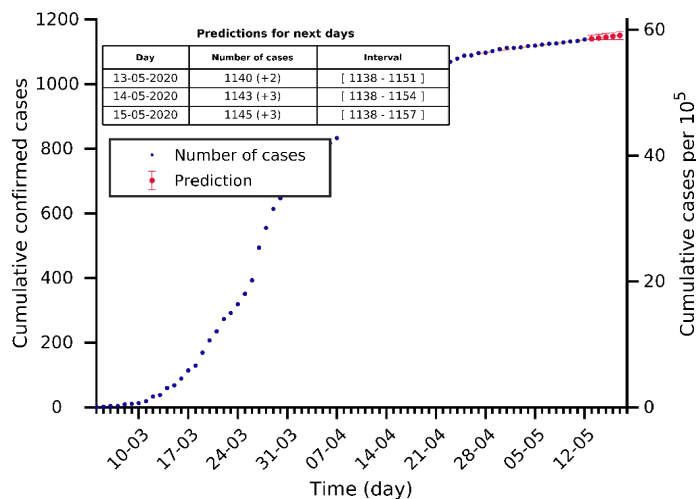
Sardegna 12-05-2020. Population: 1.6M. Current cumulated incidence: 82/10⁵



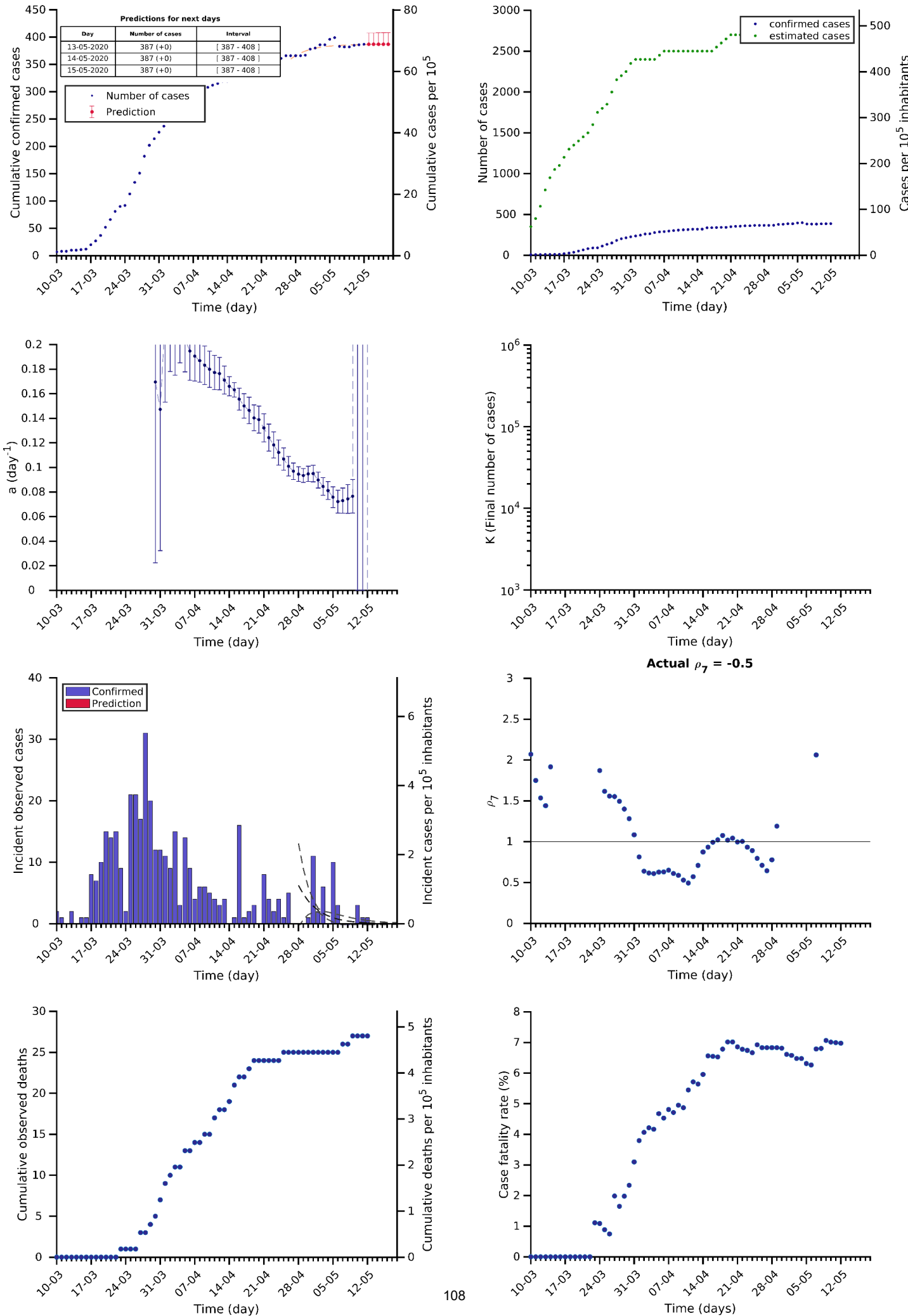
Valle d'Aosta 12-05-2020. Population: 0.1M. Current cumulated incidence: 921/10⁵



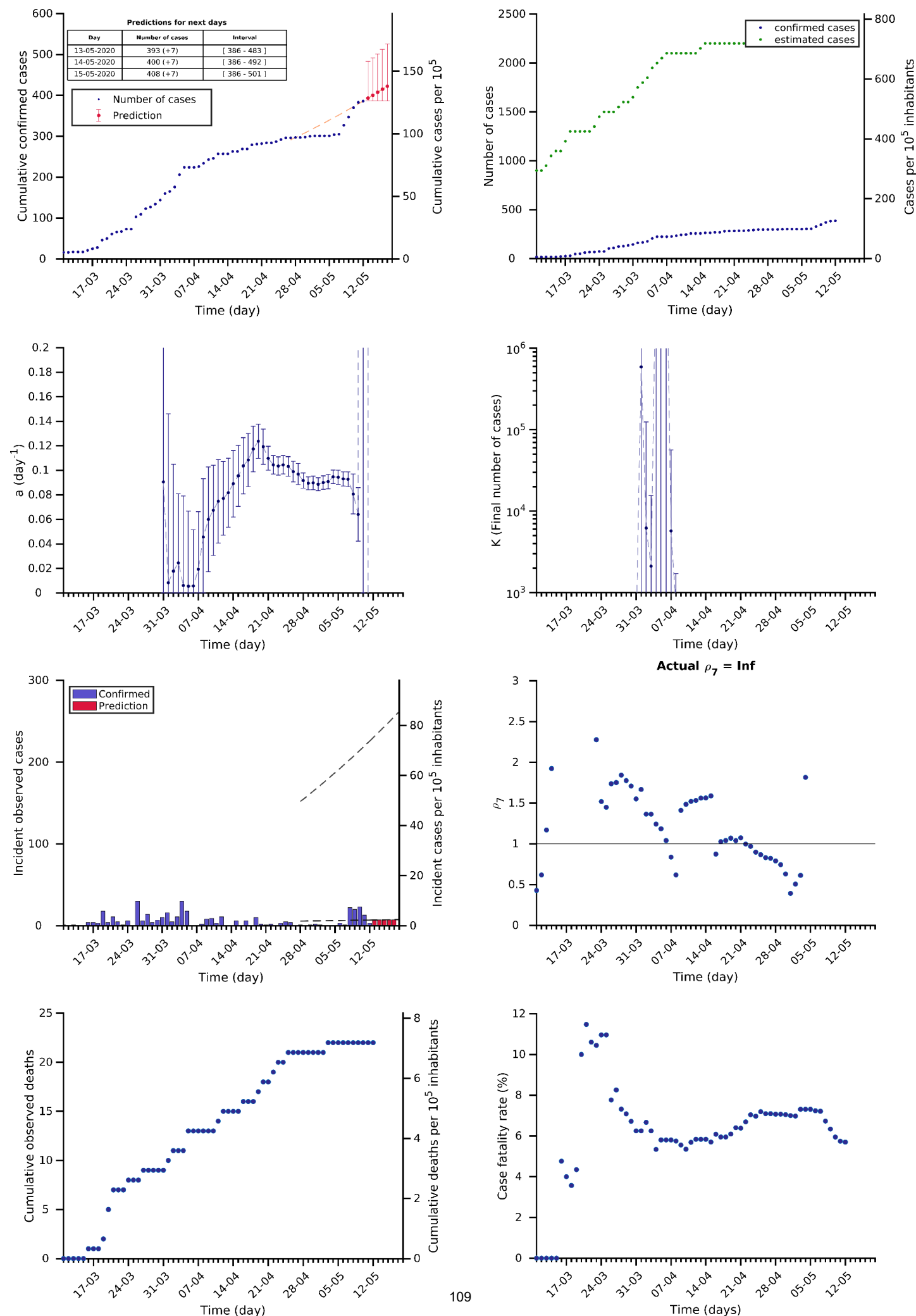
Calabria 12-05-2020. Population: 1.9M. Current cumulated incidence: 58/10⁵



Basilicata 12-05-2020. Population: 0.6M. Current cumulated incidence: 69/10⁵



Molise 12-05-2020. Population: 0.3M. Current cumulated incidence: 126/10⁵



Methods

Methods

(1) Data source

Data are daily obtained from World Health Organization (WHO) surveillance reports¹, from European Centre for Disease Prevention and Control (ECDC)² and from Ministerio de Sanidad³. These reports are converted into text files that can be processed for subsequent analysis. Daily data comprise, among others: total confirmed cases, total confirmed new cases, total deaths, total new deaths. It must be considered that the report is always providing data from previous day. In the document we use the date at which the datapoint is assumed to belong, i.e., report from 15/03/2020 is giving data from 14/03/2020, the latter being used in the subsequent analysis.

(2) Data processing and plotting

Data are initially processed with Matlab in order to update timeseries, i.e., last datapoints are added to historical sequences. These timeseries are plotted for EU individual countries and for the UE as a whole:

- ✓ Number of cumulated confirmed cases, in blue dots
- ✓ Number of reported new cases
- ✓ Number of cumulated deaths

Then, two indicators are calculated and plotted, too:

- ✓ Number of cumulated deaths divided by the number of cumulated confirmed cases, and reported as a percentage; it is an indirect indicator of the diagnostic level.
- ✓ ρ : this variable is related with the reproduction number, i.e., with the number of new infections caused by a single case. It is evaluated as follows for the day before last report ($t-1$):

$$\rho(t-1) = \frac{N_{new}(t) + N_{new}(t-1) + N_{new}(t-2)}{N_{new}(t-5) + N_{new}(t-6) + N_{new}(t-7)}$$

where $N_{new}(t)$ is the number of new confirmed cases at day t .

(3) Classification of countries according to their status in the epidemic cycle

The evolution of confirmed cases shows a biphasic behaviour:

- (I) an initial period where most of the cases are imported;
- (II) a subsequent period where most of new cases occur because of local transmission.

Once in the stage II, mathematical models can be used to track evolutions and predict tendencies. Focusing on countries that are on stage II, we classify them in three groups:

- Group A: countries that have reported more than 100 cumulated cases for 10 consecutive days or more;
- Group B: countries that have reported more than 100 cumulated cases for 7 to 9 consecutive days;
- Group C: countries that have reported more than 100 cumulated cases for 4 to 6 days.

¹ <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>

² <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

³ <https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov-China/situacionActual.htm>
<https://github.com/datadista/datasets/tree/master/COVID%2019> , <https://covid19.isciii.es/>

(4) Fitting a mathematical model to data

Previous studies have shown that Gompertz model⁴ correctly describes the Covid-19 epidemic in all analysed countries. It is an empirical model that starts with an exponential growth but that gradually decreases its specific growth rate. Therefore, it is adequate for describing an epidemic that is characterized by an initial exponential growth but a progressive decrease in spreading velocity provided that appropriate control measures are applied.

Gompertz model is described by the equation:

$$N(t) = K e^{-\ln\left(\frac{K}{N_0}\right) \cdot e^{-a \cdot (t-t_0)}}$$

where $N(t)$ is the cumulated number of confirmed cases at t (in days), and N_0 is the number of cumulated cases the day at day t_0 . The model has two parameters:

- ✓ a is the velocity at which specific spreading rate is slowing down;
- ✓ K is the expected final number of cumulated cases at the end of the epidemic.

This model is fitted to reported cumulated cases of the UE and of countries in stage II that accomplish two criteria: 4 or more consecutive days with more than 100 cumulated cases, and at least one datapoint over 200 cases. Day t_0 is chosen as that one at which $N(t)$ overpasses 100 cases. If more than 15 datapoints that accomplish the stated criteria are available, only the last 15 points are used. The fitting is done using Matlab's Curve Fitting package with Nonlinear Least Squares method, which also provides confidence intervals of fitted parameters (a and K) and the R^2 of the fitting. At the initial stages the dynamics is exponential and K cannot be correctly evaluated. In fact, at this stage the most relevant parameter is a . Fitted curves are incorporated to plots of cumulative reported cases with a dashed line. Once a new fitting is done, two plots are added to the country report:

- ✓ Evolution of fitted a with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out;
- ✓ Evolution of fitted K with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out; if lower error bar indicates a value that is lower than current number of cases, the error bar is truncated.

These plots illustrate the increase in fittings' confidence, as fitted values progressively stabilize around a certain value and error bars get smaller when the number of datapoints increases. In fact, in the case of countries, they are discarded and set as "Not enough data" if $a > 0.2 \text{ day}^{-1}$, if $K > 10^6$ or if the error in K overpasses 10^6 .

It is worth to mention that the simplicity of this model and the lack of previous assumptions about the Covid-19 behaviour make it appropriate for universal use, i.e., it can be fitted to any country independently of its socioeconomic context and control strategy. Then, the model is capable of quantifying the observed dynamics in an objective and standard manner and predicting short-term tendencies.

(5) Using the model for predicting short-term tendencies

The model is finally used for a short-term prediction of the evolution of the cumulated number of cases. The predictions increase their reliability with the number of datapoints used in the fitting. Therefore, we consider three levels of prediction, depending on the country:

⁴ Madden LV. Quantification of disease progression. Protection Ecology 1980; 2: 159-176.

- Group A: prediction of expected cumulated cases for the following 3-5 days⁵;
- Group B: prediction of expected cumulated cases for the following 2 days;
- Group C: prediction of expected cumulated cases for the following day.

The confidence interval of predictions is assessed with the Matlab function `predint`, with a 99% confidence level. These predictions are shown in the plots as red dots with corresponding error bars, and also gathered in the attached table. For series longer than 9 timepoints, last 3 points are weighted in the fitting so that changes in tendencies are well captured by the model.

(6) Estimating non-diagnosed cases

Lethality of Covid-19 has been estimated at around 1 % for Republic of Korea and the Diamond Princess cruise. Besides, median duration of viral shedding after Covid-19 onset has been estimated at 18.5 days for non-survivors⁶ in a retrospective study in Wuhan. These data allow for an estimation of total number of cases, considering that the number of deaths at certain moment should be about 1 % of total cases 18.5 days before. This is valid for estimating cases of countries at stage II, since in stage I the deaths would be mostly due to the incidence at the country from which they were imported. We establish a threshold of 50 reported cases before starting this estimation.

Reported deaths are passed through a moving average filter of 5 points in order to smooth tendencies. Then, the corresponding number of cases is found assuming the 1 % lethality. Finally, these cases are distributed between 18 and 19 days before each one.

⁵ At this moment we are testing predictions at 4 days for countries with more than 100 cumulated cases for 13-15 consecutive days, and 5 days for 16 or more days.

⁶ Zhou et al., 2020. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet; March 9, doi: 10.1016/S0140-6736(20)30566-3